The FOUNDRY
June 1918
CLEVELAND, OHIO.
Vol. 46, No. 6 Whole No. 310

Pig Iron Needs of Foundries to be Surveyed

The Threatened Shortage of Foundry Grades Has Resulted in Government Action to Assure an Ample Supply for Essential Requirements

A COMPREHENSIVE survey of the distribution of the country's pig iron output from May 1 to the end of the year has been undertaken by the subcommittee on pig iron, iron ore and lake transportation of the American Iron and Steel institute. Complete control of pig iron shipments will be assumed by this subcommittee so that the available supply of iron shall be applied to the war requirements of the government and the allies in accordance with their importance. Every gray iron, steel and malleable iron foundry in the United States will receive blanks from the blast furnace interests, from which they make their pig iron purchases and these are to be filled out promptly in order that the subcommittee of the Iron and Steel institute may make an early compilation. These blanks were mailed about 10 days ago and ask for the following information: Estimated monthly pig iron consumption from May 1 to Dec. 31; total pig iron in stock and in transit on May 1; total pig iron to be delivered from all sources on all contracts from May 1 to the end of the year. Information is requested regarding the class of work for which this iron is to be used under the following headings: Orders from the Emergency Fleet corporation; orders for the navy department; orders for the war department; orders for allied governments; orders for railroad and other government work; agricultural implements, mine supplies, oil well and fuel oil machinery, machine tools, cranes and other machinery directly connected with the conduct of the war, follow in the order named. All government ordrs are to be indicated by number on the reverse side of the blank and on indirect government orders the names and addresses of the contractors are to be included. These blanks are to be returned to the blast furnace interests that have forwarded them and the data thus obtained will be entered upon another blank that is to be returned to J. Leonard Replogle, director of steel supplies, war industries board, Washington, D. C., and a duplicate is to be mailed to H. G. Dalton, chairman of the subcommittee of the American Iron and Steel institute, Western Reserve building, Cleveland. Not only are the foundries of the country asked to furnish this information, but the steel works likewise must make these reports. Information is sought on the following grades of iron; Bessemer, basic, malleable, foundry and charcoal iron.

War Developments Affecting Foundry Industry

Threatened shortage of pig iron compels a survey of the steel, gray and malleable iron foundries to ascertain tonnage for essentials and nonessentials; requirements of pig iron to the end of the year; stocks of iron on hand and purchased for delivery to Dec. 31.

Cast scrap prices probably will be reduced when government schedules of iron and steel quotations are again revised on June 30. Suggested that the maximum for cast scrap be the same as the price of No. 2 foundry iron. This will afford great relief to foundrymen on the Pacific coast. Scrap dealers have again been allowed a commission of 3½ per cent.

Ordnance department of the army revises steel casting specifications, increasing the sulphur and phosphorus maximums. Physical requirements less drastic on two classes of cast steel. No changes have been made in exacting inspection rules.

Gray iron probably will replace malleable iron for hand grenades. All malleable shops producing hand grenades have been ordered to discontinue their manufacture.

Experiments in the production of cast semisteel shells are progressing favorably.

Estimated that 500,000 tons of gray and malleable iron, steel and brass castings will be required in the construction of 100,000 freight cars and 1025 locomotives ordered by the government for the railroads.

Prices for malleable iron and steel, approved by the price-fixing committee of the American Iron and Steel institute, have been accepted by the advisory railroad purchasing committee to apply on the 100,000 freight cars purchased by the government for the railroads. The malleable prices are printed on page 241. The prices of steel car castings were published on page 59 of the April issue.

The most essential purpose of this survey is to provide an ample tonnage of all grades of pig iron for the foundries engaged on all classes of government work and in the production of castings that indirectly are necessary in construction of ordnance and equipment for carrying out the war program. The tonnage of pig iron going to casting plants engaged in the production of parts for nonessentials, of course, will be ascertained definitely by this survey, but it does not necessarily follow that the pig iron supplied to these plants is to be cut off immediately, or even considerably reduced. As previously stated, the purpose of this undertaking is to obtain definite knowledge of the amount of pig iron that will be required for government work to the end of the year and to so allocate it, if necessary, so that the plants engaged in government work will not suffer from lack of supply. The balance of iron over and above the essential needs, of course, will be distributed among the foundries engaged in the manufacture of castings classed as nonessentials.

This action was decided upon in view of the threatened pig iron shortage which has been directed to the attention of the readers of THE FOUNDRY in the April and May numbers. The program of the government continues to expand daily and now is so immense that this action was deemed necessary to solve this perplexing problem. However, in connection with the government supervision over the sale and distribution of pig iron, energetic efforts are to be made to maintain the production of the furnaces at close to 100 per cent. Blast furnace interests will be given their full requirements of coke since it is believed that the railroad transportation difficulties which have been the main factors in the irregularity of the coke supply, have been overcome. Pig iron producers, whenever their coke supply is found to be insufficient, are requested to communicate with Mr. Replogle, director of steel supplies at Washington, and to explain whether this delay arises from the lack of proper railroad transportation or is due to the failure of the coke producers to fill orders.

The following letter has been sent to foundrymen requesting them to furnish data covering their pig iron needs:

The government demands for pig iron, direct and indirect, are increasing rapidly and at the request of the war industries board, the American Iron and Steel institute has been asked to make a comprehensive survey of the situation, and therefore, all of the producers, in addition to furnishing information pertaining to their operations, are called upon to immediately canvass all of the pig iron consumers in the United States, for the purpose of mobilizing the industry on a war basis.

In order to gather this information uniformly, the institute committee has provided the necessary blanks, one of which we are enclosing herewith, and we believe will be found self-explanatory and enable you to make return of the data required in an intelligent manner for the purpose intended, so that we can make our report through the medium that the government has designated to collect these statistics.

We are expected to report within a week, and some time will be necessary to compile the figures of all the customers on our books; therefore, we cannot emphasize too strongly the importance of your giving the matter immediate and preferred attention.

Feeling confident of your willingness to heartily cooperate in hurrying the compilation of this data, which the national emergency seems to require, and thanking you in anticipation of the early return to us of the enclosed form properly filled out, we remain.

As the result of agitation for a downward revision of cast scrap prices, a special meeting of the iron and steel scrap subcommittee of the general iron and steel committee of the American Iron and Steel institute recently was held in Philadelphia. A large number of letters were presented from foundrymen throughout the United States, who contend that the existing cast scrap schedule is entirely too high and should be revised immediately. Foundrymen in New England, who offered written complaints, stated that the relief which was promised would follow the high prices named for cast scrap, has not materialized and that the shortage which has prevailed for more than six months, still continues. For this reason they feel that conditions cannot be made much worse by a downward revision of cast scrap prices. At this meeting it was decided to make no change in the present schedule until the end of June and it has been suggested that in no market of the country should cast scrap which is quoted on a delivery basis, be sold at a price higher than that quoted for No. 2 foundry iron in that district. On the Pacific coast where the consumption of scrap has been increased tremendously by the activities of foundries filling orders for castings for shipbuilding purposes and where the imports of pig iron have been cut off almost entirely, the existing scrap schedule has worked a great hardship. No. 2 foundry iron is quoted at prices ranging from $45 to $48 per ton, delivered, whereas cast scrap must be sold at a delivered price of $34. Therefore, no outside scrap is being shipped into this market, but by quoting on the basis of No. 2 foundry iron it is believed that dealers far in the interior will make shipments of scrap over long distances to Pacific coast consumers. The demand of the scrap dealers for a reinstatement of the 3½ per cent commission finally was granted by the government price-fixing committee at Washington.

Gray Iron to Replace Malleable for Grenades

THE malleable iron hand grenade program came to a sudden halt recently when reports of service tests were received by the ordnance department of the army that they did not develop satisfactory fragmentation. Before malleable iron was adopted for hand grenade manufacture an extensive series of tests was conducted for the purpose of ascertaining the relative merits of gray iron, cast steel and malleable iron for this missile. These tests greatly favored malleable cast iron since the fragmentation was much greater than that of steel and cast iron was reduced to many small fragments, the great majority of which were ineffective. The manufacture of malleable hand grenades was carried out on a tremendous scale and it is reported that most of the contracts awarded are now nearing completion. It is probable that cast iron will be the metal selected in preference to steel, and if this is finally decided in favor of the gray iron foundries, a tremendous tonnage will be diverted to these shops. Rifle grenades continue to be made by the malleable shops, many of which are approaching the final deliveries on their initial orders. Rifle grenades were tested similarly to the hand type before malleable cast iron was selected and this metal was chosen because of its more satisfactory fragmentation

Experiments continue to be made in the manufacture of semisteel shells and the tests are favorable to the final solution of the problem. According to the hydraulic tests, the density of the metal is more than satisfactory and the tensile strength is high. The ballistic tests, of course, will govern the final selection or rejection of this material for shell manufacture. In view of the steel shortage and the tremendous tonnage of shells required, experiments with semisteel cast shells will be prosecuted with great vigor. It is appreciated that if this method of manufacture can be developed satisfactorily, an almost unlimited plant capacity will be available for their manufacture and, in addition, they can be produced more speedily than when made of steel with its attendant forging, boring and machining operations.

The railroad equipment program of the government is going to be carried out on the same gigantic scale as previously outlined. Already 100,000 freight cars have been ordered and approximately 1000 locomotives have been purchased. This involves in excess of 500,000 tons of steel, gray iron, malleable and brass castings. In view of the large tonnage of castings placed with the foundries for ordnance purposes, considerable difficulty will be experienced in obtaining satisfactory deliveries for car and locomotive work. However, the gray iron and malleable foundries are in position to carry out their part of the program and are able to make deliveries as required. Prices for car castings recently submitted to and approved by the price-fixing committee of the American Iron and Steel institute, by manufacturers of malleable cast iron have been accepted by the subcommittee of the central advisory railroad purchasing committee to apply on all the malleable iron car parts and specialties that will be employed in building the 100,000 freight cars that have been ordered. This schedule of prices, given in the accompanying table, is to be reviewed by the war industries board and if found to be too high will be revised and the new prices will apply on all orders placed, the excess cost to be refunded to the railroad administration. Since this schedule of prices was passed upon by the institute, wage advances have been made by malleable iron foundrymen generally and to some manufacturers these quotations are now not very attractive. However, all have pledged themselves to serve the government to the limit of their capacity and resources and will promptly and efficiently furnish the government the castings needed by the car companies.

Agreed Prices for Malleable Car Castings and Specialties

Miscellaneous Freight Car Castings

(Cents per pound)

Quantity ordered	Under 25 pieces	26 to 100 pieces	101 to 250 pieces	251 to 500 pieces	Over 500 pieces
Draft lugs	8.90	8.00	7.35	7.15	7.00
Journal box wedges	8.90	8.00	7.35	7.15	7.00
Spring seats	8.90	8.00	7.35	7.15	7.00
Striking plates	8.90	8.00	7.35	7.15	7.00
Truck columns	8.90	8.00	7.35	7.15	7.00
Rail braces	8.90	8.00	7.35	7.15	7.00
Center plates	9.00	8.10	7.40	7.25	7.10
Center plate supports	9.00	8.10	7.40	7.25	7.10
Center sill separators	9.00	8.10	7.40	7.25	7.10
Coupler carriers	9.00	8.10	7.40	7.25	7.10
Push pole pockets	9.00	8.10	7.40	7.25	7.10
Side bearings	9.00	8.10	7.40	7.25	7.10
Back stop castings	9.05	8.15	7.50	7.35	7.20
Bolster center fillers	9.35	8.45	7.75	7.60	7.45

All Other Miscellaneous Freight Car Castings

(Cents per pound)

Weight per casting, pounds	One to 5 pieces	6 to 25 pieces	26 to 100 pieces	101 to 250 pieces	250 to 500 pieces	Over 500 pieces
Under 2	26.25	21.25	17.00	12.50	11.00	10.25
From 2 to 7	21.25	17.00	12.25	10.25	9.75	9.25
Over 7 to 15	14.75	11.50	10.25	9.25	8.75	8.50
Over 15 to 25	12.25	10.75	9.75	8.75	8.25	8.00
Over 25	11.50	10.25	9.00	8.50	8.00	7.75

Above prices are f. o. b. foundry with carload of freight allowed to points within the territory bounded by the Mississippi river on the west and the Ohio and Potomac rivers on the south. Carload rate of freight only to boundary will be allowed on shipments to points outside of the above territory.

Any pattern equipment necessary to be furnished by or at the expense of customer.

Any castings of intricate design or necessarily of very light section will be charged extra as will be agreed upon hereafter.

Army Cast Steel Specifications Revised

CONCESSIONS of far-reaching importance in the specifications for steel castings, that will materially expedite manufacture and increase the output of open-hearth and converter foundries, have been made by the ordnance department of the army as a result of the petition presented by the Steel Founders' Society of America, published in full in the May issue of THE FOUNDRY. The sulphur maximum has been increased to 0.08 per cent, where the carbon does not exceed 0.035 per cent and the phosphorus 0.06 per cent. This increase in the allowable sulphur content affords great relief to the converter steel foundries which have experienced great difficulty in complying with the former low sulphur limits. This is due to the high sulphur contained in the coke now delivered to the iron and steel shops. When melted in the cupola, before charging into the blowing vessel, the iron absorbs sulphur, and as none is eliminated in the conversion to steel it has been almost impossible to obtain a lower maximum than 0.08 per cent. Manufacturers who have claimed that the detrimental effects of sulphur are not nearly so great as generally imagined, consider this concession by the army ordnance department a great victory and they are positive that service tests will prove their contention to be correct. The increase in the phosphorus limit, though slight, will permit of the use of a large tonnage of metal heretofore eliminated by the exacting restrictions of the ordnance department.

The physical requirements also have been revised downward, with the exception of the elastic limit of cast steel No. 1, which has been increased from 25,000 to 27,000 pounds per square inch, while the tensile strength remains unchanged at 60,000 pounds. The order was issued to the inspection departments of ordnance by Brigadier General

J. H. Rice, and is another revision to the specifications for steel castings, last changed March 15, 1917. The revised physical requirements compared with those provided for by the previous specifications are given in the accompanying table.

The order also provides that cast steel No. 2 may be used in place of cast steel No. 1 in all cases where the latter is specified. In the accompanying table it will be noted that the elastic limit for cast steel No. 2 has been reduced 2500 pounds and for No. 3, 2000 pounds, while the tensile strength of both grades has been reduced 5000 pounds. The elongation and contraction, of course have been proportionately increased. The elongation of cast steel No. 1 has been increased 6 per cent and that of Nos. 2 and 3, 3 per cent, respectively. The contraction of area of No. 1 has been increased 6 per cent; No. 2, 5 per cent, and No. 3, 2 per cent.

The changes in the physical properties, however, do not entirely meet with the approval of steel foundrymen. The request was made that the physical requirements be made to conform to the standards of the American Society for Testing Materials. This was done with reference to No. 1 steel, but on No. 2 a higher elastic limit is demanded but will not be difficult to attain. However, the high percentage of elongation and reduction of area required for No. 3 steel make it a difficult specification to meet.

Revised and Former Physical Requirements for Cast Steel

Metal	Elastic limit, pounds per square inch		Tensile strength, pounds per square inch		Elongation after rupture, per cent		Contraction of area, per cent	
Cast Steel	Revised specifications	Former specifications	Revised specifications	Former specifications	Revised specifications	Former specifications	Revised specifications	Former specifications
No. 1	27,000	25,000	60,000	60,000	22	16	30	24
No. 2	32,500	35,000	70,000	75,000	18	15	25	20
No. 3	42,000	40,000	80,000	85,000	15	12	20	18

The most vital paragraph of the order refers to the changes in the chemical constituents and is as follows: "In cases where the carbon does not exceed 0.035 per cent, phosphorus may run as high as 0.06 per cent, with sulphur, 0.08 per cent. In the case of cast steel No. 3, phosphorus may not exceed 0.05 per cent, nor sulphur, 0.07 per cent."

The increase in the phosphorus limit is a big concession and in a measure will help to solve the difficulties experienced by steel casting manufacturers due to the existing scarcity of low phosphorus pig iron. An effort was made to have the phosphorus maximum raised from 0.05 to 0.06 per cent on the three grades of steel, but the ordnance department refused to consent to a change on steel No. 3, where it may not exceed 0.05 per cent. Foundrymen operating sideblow converters have been unable to meet the sulphur limits of the former specifications, and even the standard of the American Society for Testing Materials permits not over 0.05 per cent. With the sulphur limit placed at 0.07 and 0.08 per cent it will be possible for converter steel foundries to have a large amount of cast steel accepted, that heretofore has been rejected.

The committee of the Steel Founders' society that formulated the demands feels gratified over the concessions that have been secured, but keen disappointment is felt over the failure to have inspection immediately after shaking-out, or in the green, eliminated. Steel foundrymen engaged in government work claim that this inspection greatly retards the progress of the work and results in reduced output. This inspection, which is said to be absolutely unnecessary in view of inspection after cleaning, holds up castings on the cleaning floor, demands additional crane service and causes the castings to take a backward course to the annealing furnace. This delay, requiring extra floor space, crane service and the movement of the castings against the flow of the normal production, is claimed to be a serious hindrance to the foundry output and steel foundrymen have not yet given up hope of having this inspection eliminated eventually, as the manufacturers feel that there is no advantage to the inspector by this preliminary inspection.

Some years ago the clause providing for inspection in the green was inserted in the specifications at the request of the steel casting producers who felt that if castings were to be rejected by the inspector, they would save time and money by having the rejection occur as early as possible in the manufacturing process. This undoubtedly is the case when a small quantity of government castings are being handled. However, in the present crisis, with steel foundries crowded with government work, this has become a decided disadvantage. Steel foundrymen feel that the inspectors will be able to determine the quality of the castings in their final inspection, so that the elimination of this preliminary inspection will in no way affect the quality of the castings furnished to the various government departments. The stamping of heat numbers on each casting, regardless of its size is another feature of the present specifications that retards output and should be eliminated, in the opinion of steel foundrymen. The establishment of a central inspection bureau is another suggestion that has been made, but has not been acted upon. Great economies could be effected by such a bureau and it is claimed that a more efficient and experienced corps of inspectors could be developed by having them inspect steel castings solely for the various departments, instead of maintaining a corps for each government branch.

How Coke Prices Are Regulated

IN view of the many orders covering maximum prices of foundry coke issued by the fuel administration, all of the rulings made on this subject have been compiled and recently have been issued to the consuming trade. The orders of the fuel administration corrected to April 1, covering the maximum prices of coke per net ton of 2000 pounds are given in the following and in the accompanying table are contained the prices of 72-hour selected foundry coke and the dates when these prices became effective:

The price of coke shall be understood as the price per

ton of 2000 pounds, f.o.b. cars at the plant where the coke is manufactured.

All the maximum prices mentioned herein shall apply to car lots sold to consumers or to dealers for wagon delivery; any commissions paid to selling agencies or margins allowed to jobbers shall be paid by the vendors and shall not be added to the prices established hereby; except that in all cases of sale of coke manufactured east of the ninety-fourth meridian to consumers located west of the 115th meridian, where the seller assumes the responsibility for the quality and delivery of such coke and extends credit to and carries the account of the purchaser in accordance with the usual trade practices, there may be added 5 per cent to the established price of the coke, f.o.b. cars at the point of manufacture.

Wagon Delivery

In all cases where wagon deliveries are made, either by the coke producer or by dealers, a reasonable charge for such hauling and delivery may be made; such charge shall be subject to approval of the state fuel administrator.

Beehive Coke West of the Mississippi

The maximum prices for various grades of beehive coke made in the districts west of the Mississippi river, except as modified, shall bear the same ratio to the established price of coal from which the coke is made as the average contract prices of the same grades of coke has to the average contract prices of coal during the year 1912 and 1913.

Base Prices

BEEHIVE COKE EAST OF THE MISSISSIPPI RIVER EXCEPT AS MODIFIED BELOW

48-hour blast furnace or smelting	72-hour selected foundry	Crushed coke over 1-inch size	Date effective
$6.00	$7.00	$7.30	Nov. 10, '17

BY-PRODUCT COKE, EXCEPT AS MODIFIED BELOW

Run of oven	Selected foundry	Crushed over 1-inch size	Date effective
$6.00	$7.00	$6.50	Nov. 19, '17

Gas Coke

The maximum price of gas coke sold for industrial or metallurgical use shall be the price established by the United States fuel administrator for the corresponding grade of coke produced in by-product ovens.

Contracts Made After Sept. 24, 1917

No producer or vendor shall ask, demand or receive a higher price than the maximum price established by order of the fuel administrator for any coke delivered after Dec. 31, 1917, on contracts or sales made on or after Sept. 24, 1917.

Foundry Coke

The expression, "72-hour selected foundry coke," shall cover only coke selected in accordance with the usual trade practice for foundry use, and the prices named for 72-hour selected foundry coke shall in no case be charged for any shipments to blast furnaces for smelting iron or other metal. These base prices are given in the accompanying table. Specific prices are figured from these.

To these base prices there shall be added the freight rate from the competing beehive coke district which takes the lowest freight rate to the point where such by-product coke is produced, except that there shall be added, in addition, for coke manufactured in New England, 7 cents for each 5 cents above 60 cents in the freight charges per ton (2240 pounds) of coal for water transportation on the coal used in the manufacture of such coke.

Modifications of Coke Prices by the Fuel Administration

BEEHIVE COKE

	48-hour blast furnace or smelt'g coke	72-hour selected foundry coke	Date effective, 1918
ALABAMA:			
Coke made from coal mined in the Big Seam district	$6.75	$6.75	Feb. 15
New Castle Coal Co.	7.50	7.50	Feb. 15
United States Cast Iron Pipe & Foundry Co.	8.50	8.50	Feb. 15
U. S. C. S. & F. Co., if coke is made from Black Creek coal.	....	8.75	Mar. 30
Coke made from coal mined from the Black Creek, Blue Creek and Brookwood districts	8.00	8.75	Mar. 30
Empire Coal Co.	8.25	8.25	Feb., 15
Coke made from coal mined in the Nickel Plate district	7.00	7.00	Mar. 20
GEORGIA:			
Walker county	8.75	8.75	Feb. 15
OKLAHOMA:			
McCurtain Coke Co. for coke f. o. b. cars Panther on the main line of the Fort Smith & Western R. R.	10.75	11.75	Feb. 15
PENNSYLVANIA:			
Taylor and McCoy at Glen White, Blair county	7.25	8.25	Dec. 31*
Indiana county:			
Coke made from washed coal taken exclusively from the lower bench of coal taken from the Upper Freeport seam, if the ash exceeds 10 per cent or if the sulphur exceeds 0.9 per cent	8.00	8.00	Mar. 1
If the ash is less than 10 per cent and the sulphur less than 0.9 per cent	8.50	8.50	Mar. 1
Cambria county	7.25	8.25	Mar. 1
TENNESSEE:			
Sewanee Fuel & Iron Co., Lone Rock ovens at Tracy City	8.25	8.25	Dec. 31*
WASHINGTON	10.00	11.00	Mar. 30
WEST VIRGINIA:			
Preston county	6.75	7.75	Mar. 30
Flat Top or Pocahontas district.	8.00	8.00	Mar. 1
Coke made at Meridan, Barbour county	6.75	7.75	Mar. 1
Tucker county	7.00	8.00	Mar. 20
Kanawha district, Fayette county	6.50	7.50	Mar. 30
Nicholas county	7.75	7.75	Mar. 30
New River district	8.00	8.00	Feb. 15

*1917.

BY-PRODUCT COKE

	Run of oven	Selected foundry	Crushed coke oven 1-inch size	Date effective 1918
ALABAMA:				
Coke made from coal mined in the Nickel Plate district	$7.00	$7.00		Mar. 20
TENNESSEE:				
Chattanooga	8.25	9.25	$8.75	Mar. 1
WASHINGTON	10.00	11.00		Mar. 30

Aircraft Specifications for Cast Iron

The International Aircraft Standards board, working under the direction of the bureau of standards, department of commerce, Washington, D. C., has issued specifications for cast-iron airplane parts. This material is to be suitable for piston rings, cylinder liners, valve guide bushings, etc. Chemical and physical properties are covered. The specifications are as follows:

MATERIAL.—The following limits of chemical composition are desirable:

	Per cent
Total carbon, minimum	2.80
Combined carbon, maximum	0.75
Manganese, maximum	0.75
Phosphorus, maximum	1.00
Sulphur, maximum	0.12
Silicon, maximum	2.25

(*Concluded on page* 258)

How Crankcases For Sub Chaser Engines Are Molded and Cast

By H Cole Estep

EVERY phase of our tremendous war preparations touches the foundry industry at some point. In the construction of submarine chasers, for instance, a large number of powerful, high-speed marine gasoline engines are required. Before these engines can be built, a heavy tonnage of fine gray iron castings for the crank cases, cylinders, pistons, flywheels, etc., must be produced. Most of these castings are being made in foundries that have had extensive experience on automobile work. The marine engine castings, however, are much larger and radically different in important particulars from those required for automobiles. In fact, foundrymen who have had experience with both classes of work believe that greater skill is demanded in making the marine engine castings.

One of the largest manufacturers of marine engines for submarine chasers, private yachts, power boats, etc., is the Van Blerck Motor Co., with works at Monroe, Mich., and offices at 30 Church street, New York City. This concern has turned a large amount of its foundry work over to the Campbell, Wyant & Cannon Foundry Co., Muskegon, Mich. The contract with the Campbell, Wyant & Cannon company includes the production of crankcases for 4, 6 and 8-cylinder high-speed engines, and some exceedingly interesting foundry problems have been solved in executing this work. Some idea of the intricacy of the castings may be gathered from the fact thhat there are 102 cores in the mold for a 6-cylinder crankcase. In addition, the steel pipes which distribute the oil to the bearings are arranged to form an integral part of the crankcase and great precautions are necessary to insure the proper fusion of the gray iron with the surface of the pipes, there being some 20 points of contact in each casting.

A finished casting for a 6-cylinder engine is shown in Fig. 2. The oil pipes are clearly shown at the right. At each bearing there is a cast iron tee, into the stem of which a small feed pipe leading directly to the bearing is cast. It will be noted that there are two main distribution pipes opposite the three after-bearings at the top.

Solid, carefully built wooden patterns are employed. The three paterns for the 4, 6 and 8-cylinder crankcases are shown in Fig. 7. These patterns form the upper halves of the crankshaft bearings and

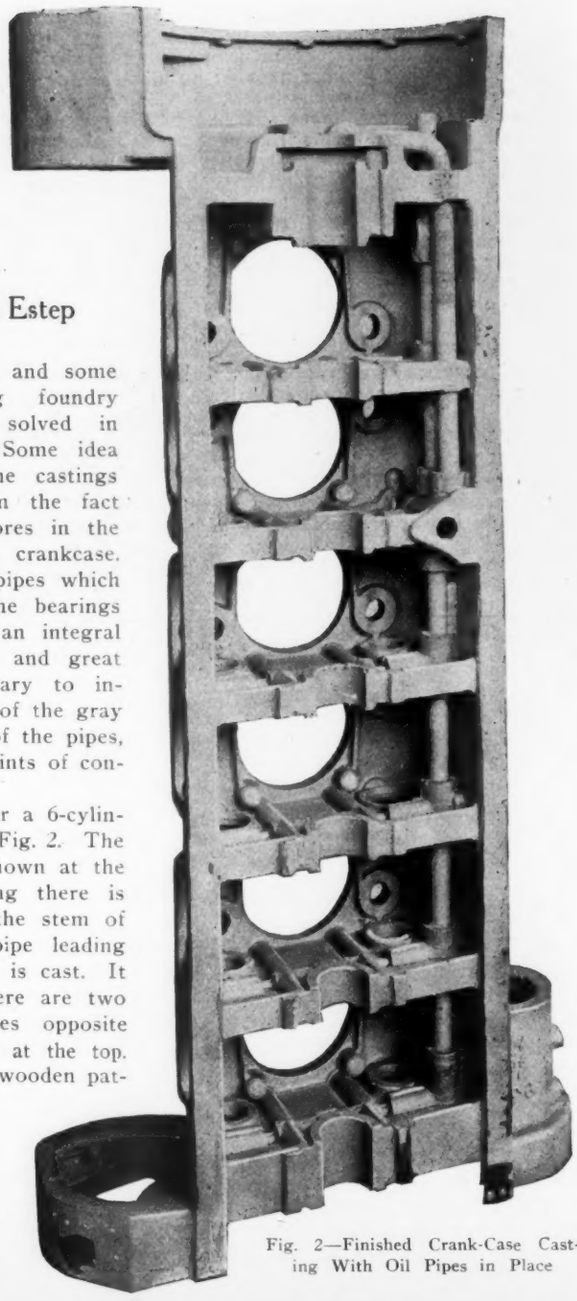


Fig. 2—Finished Crank-Case Casting With Oil Pipes in Place

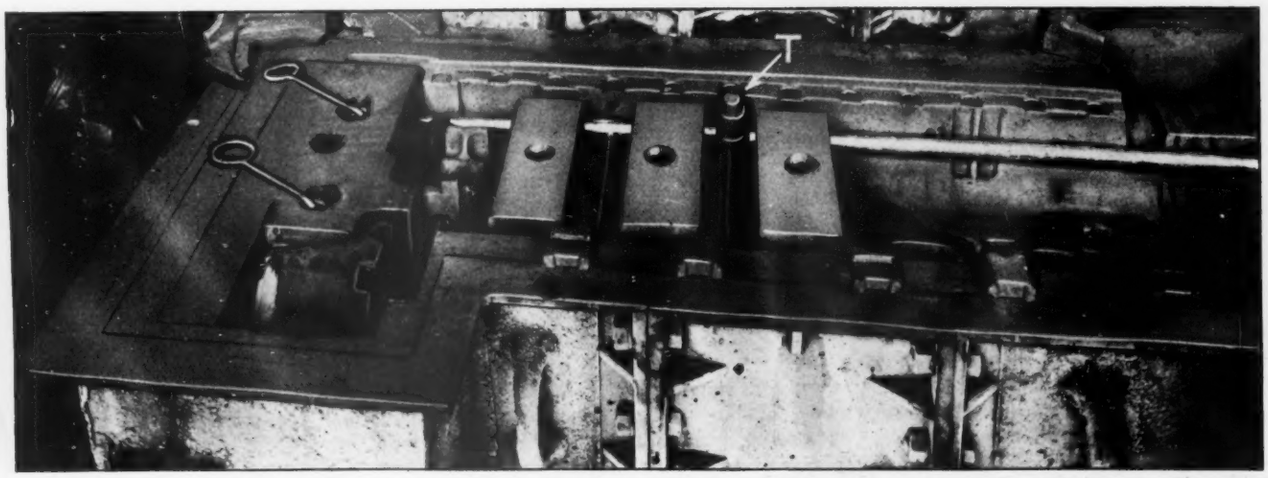


FIG. 1—AFTER THE CORES AND PIPES ARE FITTED THEY ARE RE-ASSEMBLED IN THE MOLD WHICH HAS BEEN PREVIOUSLY DRIED IN THE OVEN

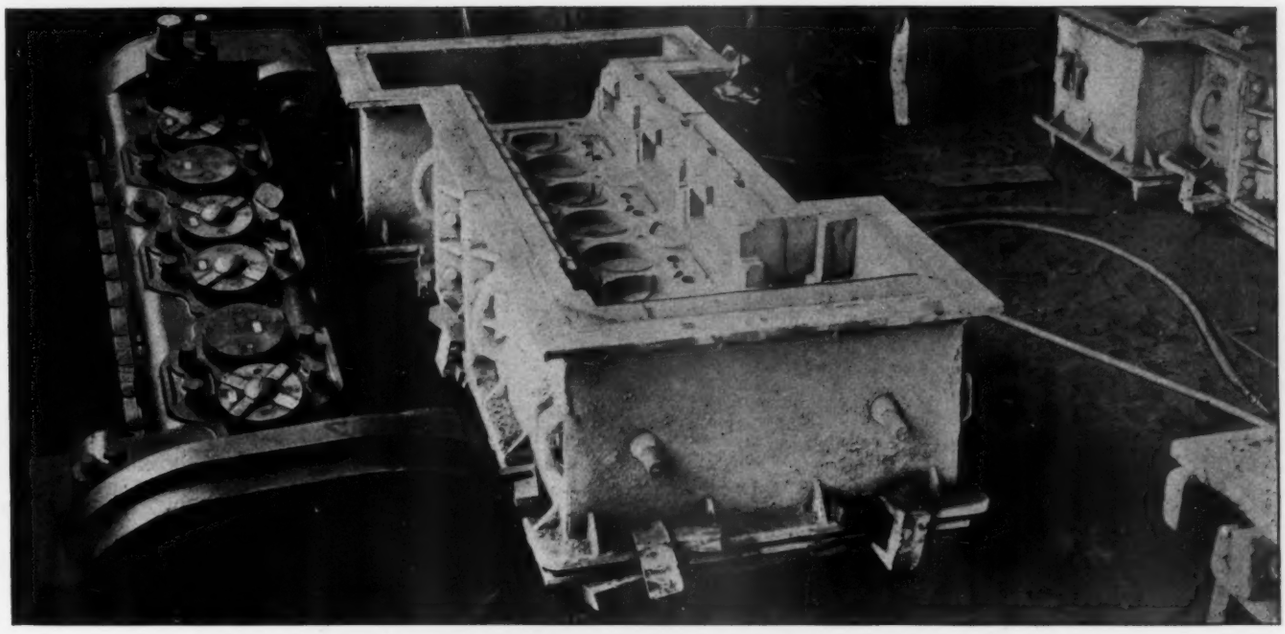


FIG. 3—THE MOLD IS RAMMED ON THE FLOOR FROM A SOLID PATTERN

the housings for the gears mounted on both ends of the engine. The prints for the cores forming the cylinder barrel openings and cylinder block bolt holes are clearly shown on the patterns. The method of gating also in indicated.

Drop gates with runners extending through the center of the cylinder barrel cores are employed. There are three runners for the 4-cylinder casting, on the first, third and fourth cylinders, respectively, with four on both the 6 and 8-cylinder castings, in the former case on the first, third, fourth and sixth cylinders, and in the latter, on the first, third, sixth and eighth cylinders. On the 8-cylinder crankcase each runner is connected to the casting by four gates, while on the two smaller crankcases, for 4 and 6-cylinder engines, only the end cylinders are provided with 4-point gates, the intermediate runners terminating in 2-point gates. These two types of gates are clearly shown at B, Fig. 7. The relative sizes of the three crankcases also are clearly indicated in this illustration. The 4-cylinder casting weighs 253 pounds after cleaning, the 6-cylinder casting, 324 pounds and the 8-cylinder crankcase 370 pounds.

FIG. 4—DETAILS OF THE POURING BASIN

The molds are made in specially designed cast iron flasks of irregular shape, as indicated in Fig. 3. The flask for the 6-cylinder casting is 5 feet 9 inches long over all. The middle section of the flask is 20 inches

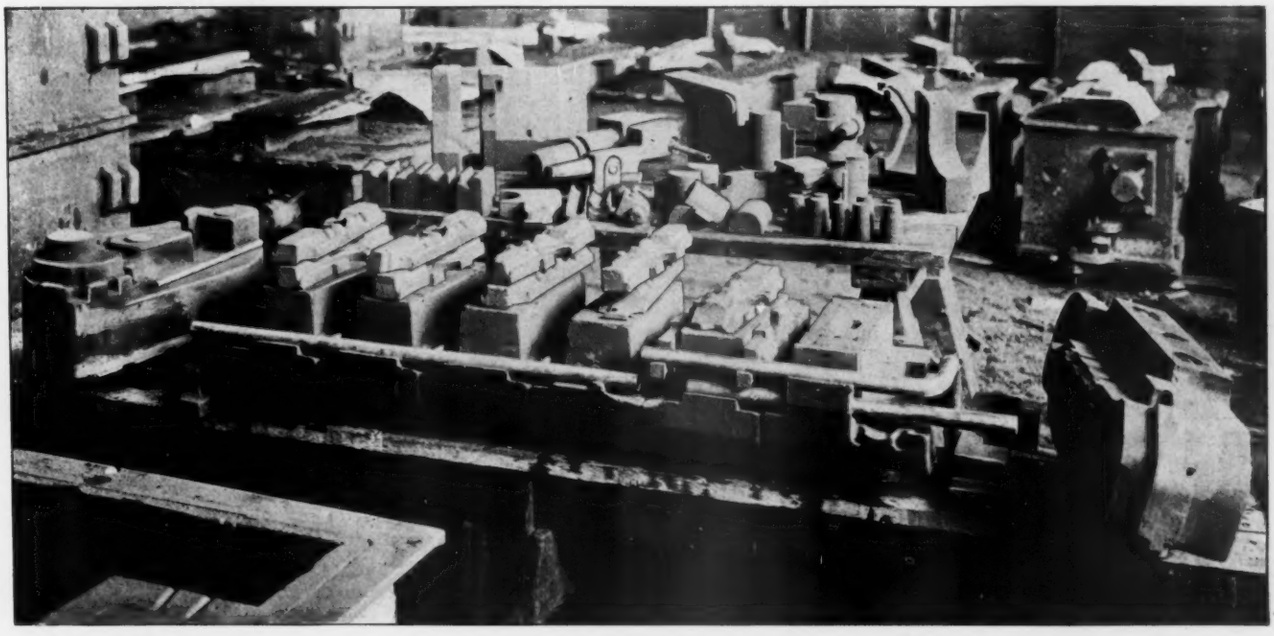


FIG. 5—THE CORES AND PIPES ARE CAREFULLY ASSEMBLED AND FITTED TOGETHER ON THE BENCH

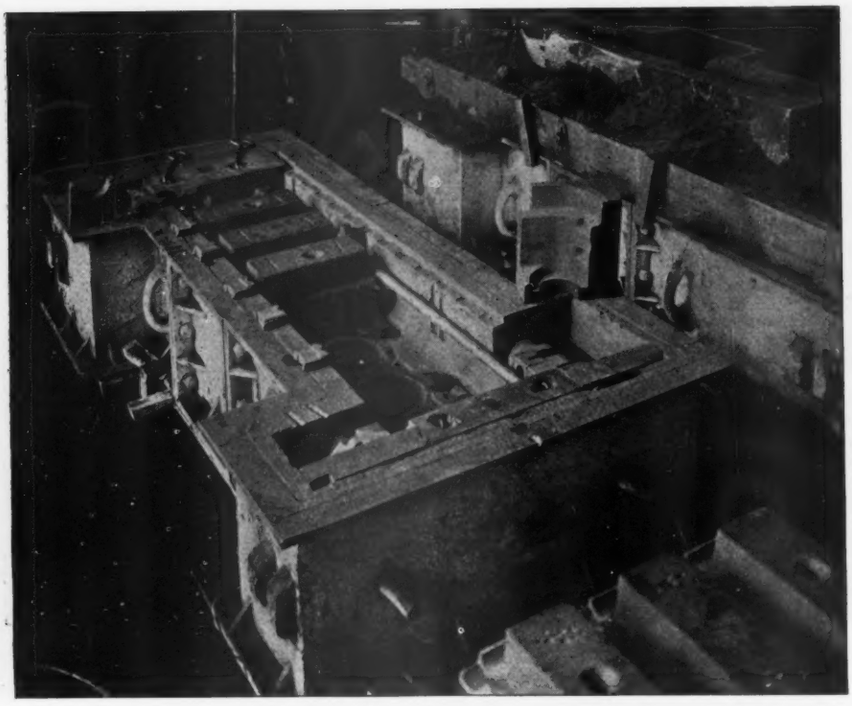


FIG. 6—DRAG WITH CORES PARTIALLY SET

wide inside. The section which forms the after or propeller end of the casting is 26 inches wide, the other end forming the camshaft gear housing being 34 inches wide. The flask in Fig. 3 is arranged with the propeller end of the casting in the foreground. The drag is 15½ inches deep. This flask is made in three sections which are bolted together, as indicated in Fig. 1. The middle section is 14 inches long. This construction makes it possible to use the same flask for the 4, 6 or 8-cylinder castings. For the smallest casting the center section of the flask is removed, the two irregular end sections being bolted directly together. One center section is employed for molding the 6-cylinder casting, another being added for the 8-cylinder job, making the flask in this case 6 feet 11 inches in length overall.

The cope shown in Fig. 4 is of plain wooden construction. It is 6 inches deep and is surmounted by a pouring basin arranged so the metal will enter all of the gates simultaneously. The cope is clamped to the drag with plain clamps and wedges in the usual manner.

Flasks are Rammed by Hand

The flasks are rammed on the floor by hand. Careful ramming supplemented by considerable hand tucking is necessary. Two men are employed on the job and two molds constitute a good day's work. This includes adjusting the pipes and fitting and setting all of the cores. No effort is made to hurry the work, stress being laid rather on the care and accuracy with which the castings are made. Thoroughly skilled molders of the type rarely found in modern foundries are employed. A cast iron bottomboard is provided and the drag is rolled over by means of a hand crane. The molds are all thoroughly ovendried before the cores are set. Fig. 3 shows the pattern and one of the finished drags for the 6-cylinder castings just before the mold is transferred to the drying oven to be thoroughly dried.

In the case of the 6-cylinder casting, there are 11 oil pipes in each mold. They are arranged as previously described and as illustrated in Fig. 1. Comparatively large pipes are employed in order to form an oil reservoir of ample size for the needs of the motor. The large distribution pipes are ¾-inch and the smaller bearing feed pipes ¼-inch; the larger pipes, therefore, are approximately 1 inch in outside diameter and the smaller pipes ½ inch. The pipes are fitted into the molds piece by piece, together with the cores. The cast iron tees which connect the distribution pipes to the individual feeds are formed of dry sand cores as indicated at *T*, Fig 1.

Cores and Pipes are Assembled

Before they are set in the mold the cores and pipes are completely assembled and properly fitted together on a low bench alongside the flask. This operation is clearly shown in Fig. 5, the large camshaft gear housing core being shown at the extreme right with the after gear housing core at the left. The cores forming the cross ribs of the casting and pipe connections are shown in a partially assembled state between the two main end cores. After the various cores and pipes have been satisfactorily fitted together on the bench, the assembly is dismounted and set up again in the mold. The latter operation is shown in Figs. 1 and 6. The distribution and feed pipes together with their connections are clearly visible in the drag which is shown in Fig. 6.

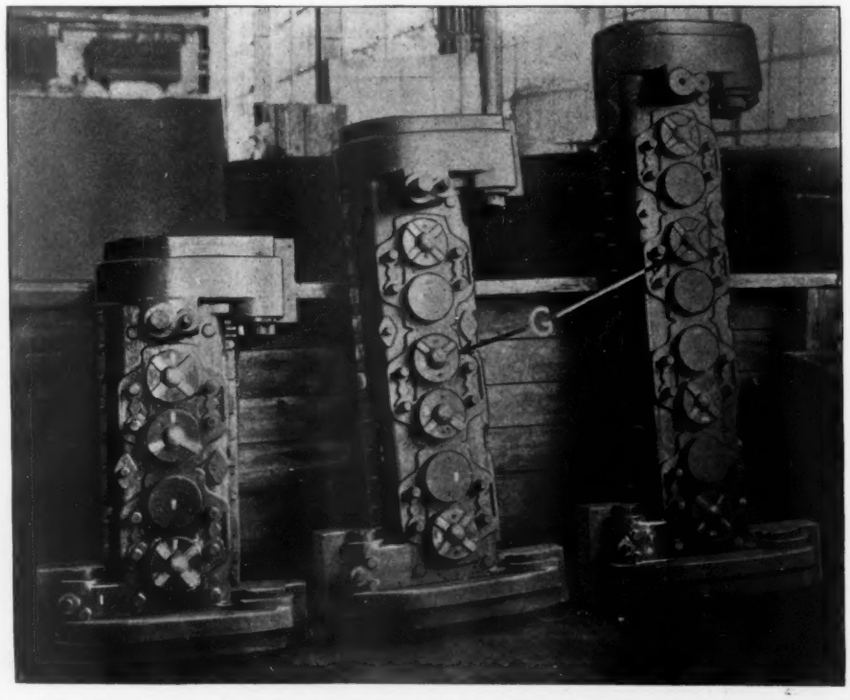


FIG. 7—PATTERNS FOR FOUR, SIX AND EIGHT-CYLINDER CASTINGS

Before they are assembled in the mold the pipes are carefully tinned and buffed in order to eliminate the oxide film which would form on the unprotected steel surface and prevent it from properly fusing with the hot iron. As an additional precaution, the pipes are painted with red lead which it is believed also acts as a flux at the points of junction. The success of the entire job hinges on the care with which the pipes are protected from oxidation by means of the tinning and red lead. Thoroughly welded joints are necessary, but there is absolutely no difficulty in obtaining results of this character if the precautions which have just been suggested are rigidly observed. In addition, the pipes are filled with loose, dry sand which is blown out after the casting is finished.

The heavy cores in the ends of the flask are handled by means of eye bolts and hooks, as shown at the left in Fig. 1.

The construction of the pouring basin is clearly shown in Fig. 4. This basin connects directly with the several runners leading to the mold. An ample head of iron is maintained. There are no risers. The gas escapes through the relatively pourous sand and the vents in the cores. After the castings are shaken-out of the flasks they are carefully finished by chipping and sand-blasting.

The Campbell, Wyant & Cannon Foundry also casts the cylinders for the Van Blerck motor. They are cast in pairs and are molded in 3-part flasks. This feature of the work presents no unusual problems. At the present time the Campbell, Wyant & Cannon company, which is headed by D. J. Campbell, president, operates one of the largest foundries in the country, devoted exclusively to the production of castings for internal combustion engines. About 1400 men are employed. The plant has grown so extensively that it now occupies two plots of ground on opposite sides of the street which bounds the original site. One of the buildings is an irregular structure approximately 260 feet square. The other is 60 feet wide and 475 feet long with an ell 62 x 245 feet. This plant is now operating at full capacity, largely on government work.

A 16-page pamphlet has been issued by Frank D. Chase, industrial engineer and architect, Chicago, which contains a reprint of an address which he presented recently before the Philadelphia Foundrymen's association. It illustrates and describes a number of the many casting plants designed and built by Mr. Chase.

Testing Engineers Have Outlined Extensive Program

A notable discussion on co-operation and industrial research, with particular application to the war, in which the various topics will be formally introduced by some of the leading scientists of the world, will feature the twenty-first annual meeting of the American Society for Testing Materials, to be held at the Hotel Traymore, Atlantic City, June 25 to 28. This topical discussion will be held on Wednesday evening, June 26, and the subject will be introduced by Dr. Henry M. Howe, chairman, engineering division, National Research council. Dr. John Johnston, secretary of the National Research council, will discuss "Recent Developments in Great Britain"; "Organization of Industrial Resarch", will be considered by Dr. A. D. Little, president Arthur D. Little, Inc., Boston; "Developments in Industrial Research", by Dr. Charles L. Reese, chemical director, E. I. du Pont de Nemours & Co., Wilmington, Del., and "Some Benefits of Industrial Research to the American Canning Industry", by Frank E. Gorrell, secretary of the National Canners association. Every member also is urged to contribute valuable data to these discussions from his own fund of experience.

The program provides for the consideration of 60 papers and committee reports in a total of 10 sessions. Two of the meetings will be devoted exclusively to ferrous metals at which the following committee reports and papers will be presented: Report of committee on wrought iron, by H. E. Smith, chairman; report of committee on cast iron, by Richard Moldenke, chairman; report of committee on methods of testing, by G. Lanza, chairman; report of committee on steel, by J. A. Capp, chairman; report of committee on corrosion of iron and steel, by S. S. Vorhees, chairman; report of committee on magnetic properties, by C. W. Burrows, chairman; report of committee on revision of pipe threads, by H. V. Wille; chairman; report of committee on magnification scales for micrographs, by W. H. Bassett, chairman; report of committee on preservative coating for structural materials, by P. H. Walker, chairman; report of committee on coke, by Richard Moldenke, chairman.

The following papers of interest to iron and steel manufacturers and foundrymen are scheduled: "Cast Steel Anchor Chain", by James French; "Grain Growth of Cold Wrought Metals", by D. J. McAdam Jr.; "Changes within the Critical Range of a Given Steel", by J. G. Ayers Jr.; "A Simple Type of Brinell Testing Machine for 500-Kilogram Load", by A. V. de Forest; "A New Type of Brinell Machine", by J. G. Ayers Jr., and "Summer Elastic-Limit Recorder", by J. L. Jones and C. H. Marshall.

The testing of aircraft materials also will be discussed and papers on this subject will be presented by I. H. Cowdrey, entitled, "Transverse Testing under Non-Uniformly Distributed Load as Applied to Airplane Wing Ribs", and G. B. Havens will discuss the "Effect of Moisture on the Strength of Aircraft Fabrics".

The most important subject to be considered under the head of nonferrous metals is "Season and Corrosion Cracking of Brass: Its Prevention and Means for Testing the Tendency Thereto". L. A. Wilson will discuss "The Valuation of Zinc Dust and a Proposed Method of Analysis", and the report of the committee on nonferrous metals and alloys will be presented by William Campbell.

G. H. Clamer, Ajax Metal Co., Philadelphia, has been nominated for the office of president, and George S. Webster, director, department of wharves, docks and ferries, Philadelphia, has been nominated for the office of vice president. The nominations for members of the executive committee follow: G. Aertsen, Midvale Steel Co., Philadelphia; G. K. Burgess, Bureau of Standards, Washington, D. C.; G. B. Heckel, editor, *Drugs, Oils and Paints*, Philadelphia, and K. W. Zimmerschied, metallurgical engineer, General Motors Co., Detroit.

The total membership of the association is 2203, which represents a net increase of 36 for the year. At the last annual meeting the total membership was 2167 and since that time 207 applications for membership have been approved; 98 members have resigned, 63 have been dropped for arrears in dues and 10 members have died.

Change Firm Name

The firm name of the Asbestos Protected Metal Co., Pittsburgh, has been changed to the Aspromet Co. When organized in 1905 the sole product of this company was asbestos protected metal, but since that time an extensive line of building materials has been added, many of which neither contain asbestos nor metal in their construction. Since the firm name no longer was considered descriptive of its operations the change was made.

Cooling Rate Affects Steel Casting Design---II

Differences of Liquid Pressure Head Result in Varying Rates of Contraction and the Results of a Study of the Cooling Phenomenon Are Presented

By J G Fletcher

THE points discussed in the first installment of this paper, published in the May number of THE FOUNDRY are of vital importance to the scientific study of steel casting design and lead us to the conclusion that the envelopes or skin zones of castings are the areas of those initial contractional stresses which, if not duly provided for, inevitably lead to trouble. Through these zones the quick temperature gradients occur; they are the equivalent of the cooling surfaces of a condenser tube of a refrigerator. These rapid temperature gradients, varying in value at different points in the casting skin, are associated with corresponding differences in contraction. In steel as in cast iron, there are two different types of crystals which make up the structure. First, the dendritic primary crystals which are the first to solidify and secondly, the more highly carburized crystals that freeze later. Each form of crystal cools at a different rate and has a correspondingly different contraction.

In the design of castings, therefore, it is necessary to consider the contractional differences in the two kinds of crystals which constitute the metallic mass. When the voids left by contraction and the escape of the occluded gases at the hot mass center of a casting are not filled by the fluid feeding metal, shrinkage cavities are inevitable.

Points Designer Should Consider

Obviously, it is the duty of the designer to see that there are no local heavy metal masses which can act as a receptacle for occluded gases from adjacent thinner and more rapidly cooling areas and which are so placed as to be incapable of being fed. The shape of the cavities or liquid contraction holes in such badly fed masses is often such as to promote serious incipient cracks. When occurring in the upper portions of castings they are most serious for there the liquid metal pressure head is least. Vent risers placed at such points, though sometimes successful in partially releasing the gases, are often dangerous, because the metal freezing before all the gas is liberated, a pipe hole or gas path may finally remain, leading from the outside of the casting to the center of the mass.

Difference of liquid pressure head at the various parts of a large casting brings about varying rates of crystalization and of contraction. A high pressure head induces more rapid and finer crystal growth than a low pressure. The recalescence is reduced in intensity by pressure and, as in the case of refractory materials heated under pressure, there is much to support the theory that the freezing point is lowered thereby. The foregoing indicates the value of long feeding heads wherever possible, of not too small a cross-section. The gas escape is promoted in the correct direction, toward the feeding heads, and the rate of contraction is lowered.

It is important to remember that contraction proceeds toward the heavy mass centers of a casting, to the metal which is the last to solidify and hence generally toward the feeding points and rising heads. In casting a number of long steel pump rods horizontally, the total contraction was over 10 inches, the rods having been 45 feet long. The feeding head was placed at one end where the metal was bulkiest, the casting having been run through a comparatively small runner from the opposite end, hot metal being used for feeding at the heavy end. The small runner was released soon after casting and there was little resistance to free contraction. It was found that the casting contracted almost entirely in the direction of the feeding head.

This example is typical and illustrates the fact that feeding points are the center towards which the remaining parts of a casting contract. Such gases as can escape through the liquid metal masses during freezing find their way to the feeding heads. If they cannot get there they are trapped on their way and become danger points. Wherever two heavy parts of a casting are united by a thin section the heavy sections serve as feeders and often act as receptacles for the occluded gases. The quick freezing of the thin connecting section may lead to contraction tears at the points of junction with the heavy section, pulling taking place while the heavy masses are still molten or semi-solid. In gray cast iron the effect of such false feeding often forms a spongy area in which coarse graphitic flakes are plainly evident.

The surface skin or envelope of a casting is the area of most contractional trouble and by remembering that the primary crystals always freeze at right angles or approximately so, to these surfaces, and by insuring the close interlocking of the two types of crystals, success in casting is attained. The surface of a casting always is in tension during the contraction which accompanies freezing and cooling, except during the dilation or expansion which occurs during the early freezing period of gray cast iron. Entrapped gases, sulphide films and globules, graphite flakes and slag inclusions, to say nothing of the accidental fused particles of facing washes, etc., must play their part in separating the crystals and in weakening their resistance to tensional or contractional stresses, acting at right angles to their axes, in directions parallel to the mold surfaces.

Cooling Rates of Different Cast Steel Sections

	Cooling surface per cubic unit cooled
Flat plate surface	1.00
Internal angle, 90 degrees	0.67
External angle, 90 degrees	1.33
Internal solid angle three planes intersecting, 90 degrees	0.43
External solid angle three planes intersecting, 90 degrees	1.14
Internal spherical surface of small radius	0.37
External spherical surface of small radius	0.75

Variations of Cooling Rate

It is clear that the skin crystals conduct the heat from the interior to the mold surfaces along their axes and it is instructive to consider closely the effect of cooling in the various types of surfaces common to castings. Assuming that unit area of mold or chill surface cools the adjacent metal in contact therewith to unit depth in unit time, the figures given in the accompanying table have been compiled.

The results given in the accompanying table, although only approximate, yield an index to the depth of the chill crystals and are roughly an indication of the degree of fineness of the crystalline structure at the mold surfaces. It will be assumed that a chill throws 1-inch depth of carbide crystals at the face of a flat plate, then the depth of chill crystal at the corner of an internal solid angle formed at the intersection of three planes in similar metal would be only 0.43 inch.

This means that the freezing is rapid on the three flat surfaces surrounding

FORMULAS FOR THE BRASS FOUNDRYMAN

Silver Solder

It is well known that for the purpose of brazing there is no alloy that can compete with silver solder for making a satisfactory joint. Therefore, in spite of its high cost, it is used extensively for brazing band saws and other metal articles requiring a strong joint. What is known as a *Common Silver Solder* is made of the following mixture:

	Per Cent
Fine silver	66.50
Copper	22.25
Zinc	11.25

Although the foregoing alloy is expensive to produce, though almost indispensable, efforts have been made to cheapen it and still retain the good flowing qualities of this solder. The following alloys are examples of the cheaper mixtures:

	Per Cent
Fine silver	50
Copper	33
Zinc	17

The above alloy has a deeper yellow color than the first one given. A cheaper mixture follows:

	Per Cent
Fine silver	37
Copper	50
Zinc	13

The color of the foregoing mixture more nearly approaches that of ordinary spelter solder than that of the other two alloys and it flows better than spelter solder.

For a solder that will melt at a low temperature and will flow easily, the following mixture is recommended:

	Per Cent
Silver	61
Copper	20
Zinc	14
Tin	5

The addition tin lowers the melting point and hardens the solder.

FORMULAS FOR THE BRASS FOUNDRYMAN

ODD AND UNUSUAL ALLOYS

Helmet Metal

This is a somewhat meaningless name for an alloy, but the mixture has been on the market several years and is used as a spring metal. Its composition follows:

	Per Cent
Copper	72
Zinc	28

This alloy is simply a yellow brass minus the tin, and resilience is imparted to it by cold-rolling or drawing. The greatest resilience is imparted by working it near to the fatigue point. Helmet metal is too soft a mixture for sand castings and is not used for this purpose.

Montana Gold

This alloy formerly was used extensively for table flat ware. It resembles 18-carat gold when polished, and with the exception of the aluminum content, is practically the brass known as *Gilding*. The composition of Montana gold is approximately as follows:

	Per Cent
Copper	89.00
Zinc	10.50
Aluminum	0.50

Platinoid

This alloy is in widespread use as an electrical resistance metal. It is practically a 25 per cent nickel silver. Its composition follows:

	Per Cent
Copper	53.50
Manganese Copper (30 Per Cent)	0.50
Nickel	24.50
Zinc	21.00
Iron	0.50

Noheet Metal

This alloy is used as an antifriction metal and at one time was widely exploited. The fact that it contains neither tin, antimony nor copper was emphasized, although these metals have never been considered detrimental to such alloys, but the reverse. The composition of *Noheet* metal follows:

	Per Cent
Lead	98.41
Sodium	1.40
Tin	0.08
Antimony	0.11

An easy way of making this alloy is to melt the lead until it is just liquid, when 2 per cent of sodium is added.

Nonpariel Antifriction Metal

This alloy has been on the market for an extended period and by analysis has the following constitutents:

	Per Cent
Lead	78.35
Antimony	16.70
Tin	4.95
Copper	Trace

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note-book form.

THE FOUNDRY DATA SHEET, JUNE, 1918

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

the contained solid angle, but that it is slow around the apex of the solid angle. Fine crystals with great resistance to contractional tearing are formed in the first case and coarser crystals with less cohesion in the second case. This explains why it is that at such solid internal angles the apex is so often porous, not infrequently leading to small gas cavities, the slowly cooling liquid metal there acting as a receptacle for the gases ejected from the surrounding, rapidly freezing crystals. A considerable radius obviously is necessary before the corner can freeze to the depth of the adjacent plates.

Determining Rate of Contraction

The rate of contraction in any part of a casting is determined by the amount of cooling surface presented to each cubic unit of metal. The specific heat of cast iron, steel and of molding sands and compositions, at high temperatures, 800 degrees Cent. and over, is not yet definitely known, but the specific heat of molding sand easily is twice that of cast iron or steel. The rate of heat conduction per square inch of sand surface is from one-tenth to one-twenty-fifth that of steel or cast iron, while that of air or CO or CO_2 gas may be taken at one-third to one-half of steel or iron. It is evident, therefore, that during the time the metal is in contact with the mold surface, the cooling action is relatively slow. As the metal freezes and contracts away from sides of the mold, the air gap action speeds up the cooling action. Local areas of dampness due to accident at the mold surface rob the casting of heat rapidly at such points and lead to prematurely frozen spots, sudden formation of steam, disintegration of the mold surface, scabs and surface tears.

It is impossible to discuss comprehensively the question of designing castings except in the most cursory manner, the myriad forms making it necessary to refer briefly to the dominant types. The following may be taken as representative:

1—Hollow cylindrical forms, thin or thick, long or short relative to the diameter; ribbed, flanged, of constant or varying diameter or thickness.

2—Plate-like forms of uniform or varying thickness, plain, ribbed or flanged.

3—Box forms with flat or curved sides, internally or externally ribbed or plain.

4—Combinations of 1, 2 and 3.

5—Wheels, rims, or hoops with or without arms, with plain or toothed peripheries, with light or heavy center bosses.

6—Discs of uniform or varying thickness, thin rims and heavy bosses, heavy rims and light bosses; thin or heavy webs, ribbed, plain or perforated.

The old and well-tried advice that sharp corners should be avoided and that the thickness of castings of intricate form should be as uniform as possible must always stand good. Designs which embody these defects are impossible, but there are many other considerations to be borne in mind. A pattern may be so made that the mold may be wrongly constructed from the point of view of contraction, gas escape or the proper placing of the casting heads or runners. How many poorly-made patterns have to be sledge-hammer rapped before they will draw? Many defects are due to high velocity casting streams directly impinging on the bottoms of direct run molds from deep ladles. The value of efficient means for breaking the stream velocity and of correct teeming rates is more important in the case of castings than in that of ingots. If the heavy portions of a casting are adjacent to thin parts and there is no possibility of feeding the heavy sections except through the thin ones, pulls or tears and internal cavities are inevitable. Many castings are so designed that there is no chance of placing efficient casting or feeding heads in the position imperative for the proper feeding of heavy sections. Some of the simplest forms have given the greatest trouble, for example, large discs with heavy rims and thin webs.

In many cases a study of the cooling rate values at the different portions of a casting will point out the possibility, or otherwise, of a design. The designer should know the laws governing the flow of liquid metals and he should have more than a casual acquaintance with the molding art. It is not fair to expect the steel founder to produce successfully, castings of doubtful design, although he often is at the mercy of such caprices. In these days of intricate machinery the steel founder constantly is experimenting, at great cost, with new and untried designs, often with serious losses in wasters whose defects are discovered only in the final machining operations.

Producing Thin Steel Castings

There is no doubt that thin, sound castings have been produced having a cooling ratio of 2¼ or 8 square inches of cooling surface per cubic inch of adjacent steel. Such a ratio, however, is impossible in larger castings. There is a limit to the distance such thin streams can travel without becoming viscous, sluggish and gassy. This depends on whether the path is direct or tortuous. Where a thin stream has to pass through a quick change of section, for example where a heavy rib or boss has to be traversed, and emerge therefrom into a thin section again, the stream velocity is checked at the heavy section and the possibilities are against the remoter thin sections being solidly filled.

The annealing of steel castings is a subject worthy of the most careful consideration. The proper temperatures are now well understood, the upper soaking point varying slightly with the carbon content and considerably when alloy steel castings have to be treated. The mixture of large and small pieces in the same furnace leads to heavy scaling of the smaller castings. Heavy castings are liable to underannealing on the surfaces touching or near to the furnace floor, while the upper portions may be overannealed.

Importance of Feeding Heads

Draw and shrink-holes, pulls and gas cavities, all are related and are influenced by the efficiency of feeding heads. It has been pointed out that liquid pressure is a factor in crystalline structure, surface strength and contraction and is of extreme importance in obtaining really effective feeding. The author hopes that some of the principles discussed will be useful in encouraging such designs of castings as shall insure non-stressed envelopes, a possibility of applying feeding heads of ample size and in correct positions, and such a disposition of the surface as shall not tend to early crystalline rupture or separation.

The molder must see to it that the rigidity of his molding material is not too great so that, without too drastic baring or releasing of a semi-frozen metal, there is a yieldability or collapsibility of core and mold alike. This will permit the tender skin crystals which later are so vital to the value of the casting, to grow and interlock without undue resistance. The outer skin of a casting often is deceptive as an indication of the actual condition of things just below that skin. The film of oxide, or graphitic or silicious face wash often covers a mass of minute blowholes which are revealed by such drastic cleansers as the sand-blast or the pickling bath. The pickling of steel castings previous to galvanizing often is a revealer of the defects of design, of molding and of casting.

Not all these defects are due to occluded gases, being sometimes the result of damp molds, the steam generated therefrom in trapped corners leading to a steam penetration of the casting skin especially at such a point as the apex of the external angle of the intersecting planes which often is in a molten state when the surrounding plates are frozen.

A 4-page circular, issued by the Clarage Fan Co., Kalamazoo, Mich., manufacturer of heating, ventilating and drying apparatus, is devoted to sectional drying cabinets adapted for drying food products, drugs, chemicals, etc.

The New York office of the Aspromet Co., Pittsburgh, has been removed to 170 Broadway.

Gas Fired Ovens For Baking and Drying Cores

Artificial and Illuminating Gas Prove Effective as Fuel for Drying Ovens—Different Installations Required for Varying Oven Types

By Bruno Rahn

ARTIFICIAL or illuminating gas has been used as a fuel in foundries for a number of years, and has proved satisfactory in a large number of core-oven installations, in brass, malleable iron, steel and gray iron shops. Industrial experience has demonstrated that ordinary city gas may be used successfully for baking small cores in the rotary tray, drawer and car types of ovens. In addition to this class of work, illuminating gas is used in larger ovens for drying large cores and molds.

Rate of Drying Important

Small cores may be baked rapidly, but when large cores are heated too fast the outer portions become crusted before all the moisture has been driven out of the inner parts. This causes surface cracks and irregular results. Successful core baking depends chiefly upon temperature control. The temperature of the oven should be raised slowly and uniformly to a certain point and then held there for a given length of time. Cores are baked at temperatures varying from 380 to about 450 degrees Fahr., depending upon their size and shape and the composition of the core mixture. When a core is subjected to excessive heat, burning results, the life of the binding mixture is destroyed, and the core is a total loss. When a core has not been baked sufficiently, it is partially green and fragile and will break either in handling or when placed in the flask. If the core fails during or following the pouring, the result is a spoiled casting. Considerable loss in production may accrue on account of improperly baked cores, due either to overheating or underheating.

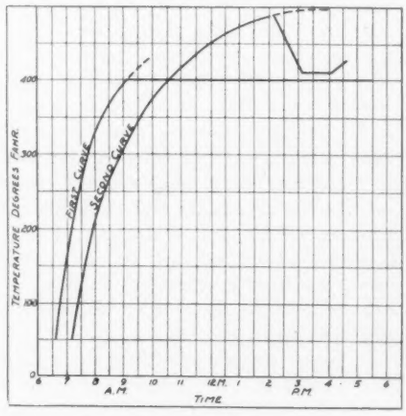


FIG. 1 — TIME-TEMPERATURE CURVES FOR GAS-FIRED OVEN

Gas heat produced by a number of individually controlled burners, permits of sensitive temperature control. Domestic experience with gas has demonstrated this property of gas heating to foundrymen. Gas fuel does not require storage space, labor in handling or firing, nor ash removal. Repairs and replacements in furnace arches or grates are avoided, as they are not used in gas fired ovens, and troubles sometimes encountered due to imperfect fuel combustion are minimized. No auxiliary apparatus is required to deliver or fire the gas. In addition labor costs are less where gas-fired ovens are employed. Factory regulations approve the use of gas by reason of the absence of unhealthful gases of incomplete combustion.

Baking Small Cores with Gas

Fig. 2 illustrates an installation of a battery of drawer-type core ovens heated with artificial gas, and used for drying small cores. The shell of each oven is 6 feet 8 inches high, 4 feet wide and 6 feet 7 inches deep. The trays are each 3 x 6 feet. Each oven is heated by two drilled pipe burners, equipped with individual pilot lights and cast iron baffle plates. The air is supplied at atmospheric pressure. The ovens are well insulated and placed upon a fireproof sub-base of concrete of the same thickness as the concrete floor. An operating temperature of about 400 degrees Fahr. gives a gas consumption varying from 275 cubic feet to 300 cubic feet per hour per oven. Each oven will keep from 8 to 10 men busy.

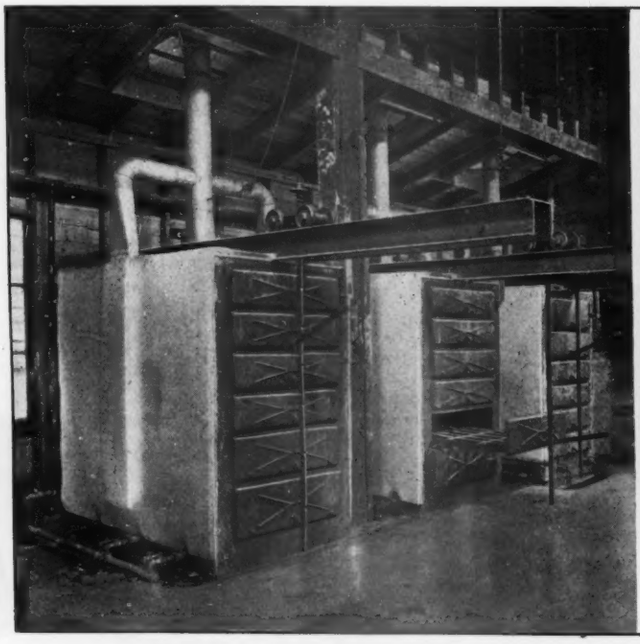


FIG. 2—GAS-FIRED DRAWER TYPE OVEN HEATED WITH BURNERS PLACED TRANSVERSELY

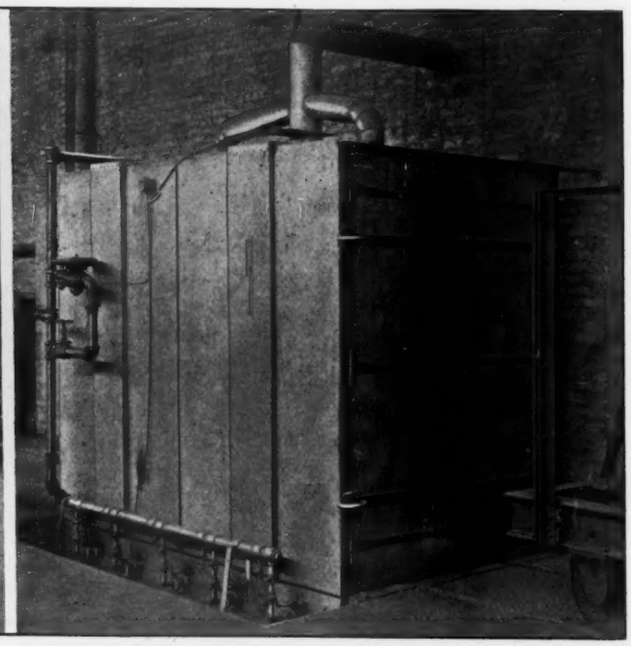


FIG. 3—A CAR TYPE OVEN FOR MEDIUM SIZED CORES—TWO CARS EMPLOYED IN THIS CASE

The illustration shows the simplicity of the entire installation. The first cost of the installation is low as there is no need for brick settings or underground furnace construction. Each oven is provided with a thermometer.

Fig. 1 shows two time-and-temperature curves plotted from observations made with a gas-heated core oven of the type just described during two regular working days. The first curve shows that the temperature can be brought up evenly to 400 degrees Fahr. and then maintained at this point for the rest of the day. The second curve shows that the temperature can be brought up rapidly and evenly to about 500 degrees Fahr. and then decreased or increased promptly by proper burner manipulation. The gas-heated drawer-type oven is popular with coremakers for several reasons. Operators are not exposed to core fumes or direct heat from the oven as the backs of the drawers completely close up the oven when the trays are hauled out for loading. Where coremakers are working on the piecework basis, as is customary in many foundries, the high percentage of well-baked cores due to proper heat regulation, insures pay for all work done.

Gas for Car-Type Ovens

Fig. 3 illustrates a car-type oven heated with gas for baking medium sized cores. This oven is 8 feet 6 inches long, 5 feet wide, and 8 feet high. It is equipped with swinging doors at both ends and is provided with two cars. One car loaded with cores is placed in the oven for baking, while the other is being loaded outside with green cores. This constitutes practically a continuous core baking process. This type of oven is also heated by means of drilled-pipe burners, which are provided with an automatic thermostatic gas shut-off control. The thermostat installation is illustrated. The oven is well insulated, and has the advantage of speed as no time is lost in loading or unloading the cores.

In Fig. 4 is shown the interior of a car-type brick core oven, heated with city gas and used for baking large cores and for drying molds. The inside measurements of the ovens are length, 32 feet, width, 10 feet 8 inches and height 9 feet 9 inches. The oven is equipped with two drilled-pipe burners, 30 feet long, installed along the side of the wall as shown. The air is delivered under pressure. The temperatures during the baking period are recorded by means of Bristol recording thermometers. Usually the burners are lighted at 6 p. m. and the temperature in the oven is rapidly increased to about 30 degrees Fahr. after which a gradual increase in temperature takes place for about three hours. The maximum temperature to which the oven is heated is 500 degrees Fahr. The gas is then shut off, awaiting the removal of the loaded car. The 30-foot gas burners can be adjusted so as to consume from 1200 to 2000 cubic feet of gas per hour each.

An even heat distribution is obtained throughout the oven. The result is a high core yield, a considerable item where large cores are concerned; time and labor saving due to ease of operation and absence of fuel cartage; and low maintenance charges on car wheels and axles, through the avoidance of extremely high temperatures.

Fig. 5 is an illustration of a core room in a small brass foundry, showing a gas heated core oven equipped with revolving trays.

The advantages which recommend gas-heated core ovens include: Uniform temperatures, insuring even baking of cores without burning; the elimination of loss on account of faulty baking; speed of operation with quick initial heating; no dying down of fires; saving in labor; no need for fuel storage or transportation; cleanliness of operation, resulting in sanitary conditions for workmen; and comparatively low installation costs.

FIG. 4—GAS BURNER EQUIPMENT OF CAR TYPE BRICK OVEN FOR LARGE CORES AND MOLDS

FIG. 5—GAS HEATED REVOLVING TRAY CORE OVEN IN USE IN A BRASS FOUNDRY

Newark Foundrymen Elect Officers

The Newark Foundrymen's association, Newark, N. J., has re-elected the following officers for the coming year: President, A. E. Barlow, Barlow Foundry, Inc., Trenton, N. J.; vice president, George Krouse, Jersey City; treasurer, John Campbell, Maher & Flockhart; secretary, Ulrich Eberhardt, Gould & Eberhardt. The following executive committee was re-elected: Gerald Hannay, James Flockhart, George Krouse, Paul Debevoise, Louis Sacks. Mr. Debevoise now is serving in France as a major of infantry.

It was reported at the last meeting of the association that the foundry division of the Liberty loan committee in Newark subscribed in the aggregate to $70,000,000 worth of Liberty bonds of the third issue.

Machine Companies Unite

The business of the J. F. Webb Mfg. & Supply Co., Davenport, Iowa, manufacturer of molding machines, has been absorbed by the E. J. Woodison Co., Detroit. J. F. Webb has become affiliated with the Woodison company and will take charge of its molding machine department. The line of machines formerly manufactured by Mr. Webb include air squeezers of all sizes and the Woodison company now is manufacturing electric jar-ramming, pattern drawing and roll-over molding machines.

To prevent a grinding wheel from loading while grinding aluminum, soak the wheel overnight in oil. After the wheel is mounted in the morning, revolving discards superfluous oil.

Refractory Materials Used in Casting Plants---I

Application of Acid, Basic and Neutral Refractories is Discussed and Interesting and Valuable Tests for Silica Brick Are Presented

By H C Arnold

EARLY in the history of metallurgy it was found that metals could be obtained from their compounds by reactions carried on at high temperatures which would not proceed under normal conditions. This fact led to the demand for a container in which such reactions could take place at high temperatures, but which would be entirely resistant to the action occurring and the heat developed. The early workers in metal used natural-occurring clays and clay mixes in fashioning their crucibles, cupelling furnaces and hearth furnaces. Thus, early in the history of metallurgy it was found that natural-occurring clays possessed this property of resistance to heat. With the nineteenth and twentieth century developments in metallurgical processes, the demand for refractories of a definite nature has increased. The other required properties also have increased to include not only resistance to high temperature, but quickly changing temperature, resistance to the metal and the slag produced, the action of flames and gaseous productions of combustion, resistance to an abnormal abrasive action, and possession of high compressive strength. A refractory, in its application to metallurgical work, may be defined, then, as any substance applied as a lining to a container, which resists the action of heat, and other actions occurring during the operation.

Properties of Good Refractories

No substance used possesses all the required properties, but combinations of substances have been determined which can be used. Up to the present those materials found best suited are compounds of alumina, silica, lime, magnesia, chromic oxide, carbon and a few metals, such as nickel and platinum. These substances may be used singly or in combination as compounds. Usually they do not possess all of the properties required of a refractory alone, and must be mixed, or used in the form of a compound.

The selection of a refractory, and even the design of a furnace itself, will depend largely upon the nature of the slag formed and the temperature required. Slags, depending upon the quantity of silica present, can be divided into acid, neutral and basic. Those which possess an acid nature will tend to react with bases to form a neutral salt; those high in bases will react with acids to produce a neutral salt. A basic slag would attack an acid refractory and dissolve enough of the lining to produce a neutral salt; and vice versa, and acid slag would attack a basic lining. Because of this nature of slags and the necessity of resisting any such corrosive action, refractories are produced of three different characters—acid, basic and neutral.

The acid refractories consist of those high in SiO_2 such as ganster and quartzite which occur in nature, and preparations of these substances either in the mass or as silica brick. The basic refractories include magnesium carbonate and dolomite, a mixture of magnesium and calcium carbonates. The neutral refractories make up the largest division and include the fire clays, pure or nearly pure alundum, which is prepared from bauxite, silicon carbide compounds, carbon, chrome iron ore and various others.

The acid refractories are those high in silica which possess a high melting point. Such materials occur abundantly in nature. Quartzite, or ganister, sandstone, granite, gneisses and rhyolites—all have been used in the linings of furnaces in the natural state. Large blocks were cut from the mineral, trimmed to shape and used as linings. They were completely resistant to the action of the heat, but did not possess the other properties required for good refractory linings. Rapid heating and cooling caused splitting, cracking and spalling. High quartz materials, when heated, suffered permanent expansion beyond their normal expansion due to heat changes. They find application where expansion can take place with no harmful results. At present the natural rock is used as a quartzite cement and mortar in sintered bottoms of open-hearth furnaces, and copper reverberatory furnaces. The natural blocks, however, have given way to the artificially prepared quartzite or silica bricks in the roofs and side walls of the previously mentioned furnaces.

The quartzites of commercial importance in America are: The Medina, of Huntingdon and Blair counties, Pa.; that of the Baraboo district, Wisconsin, and the eastern Alabama deposits. The analyses are:

	Medina quartzite, per cent	Baraboo quartzite, per cent	Alabama quartzite, per cent
Silica	97.80	97.15	97.70
Alumina	0.90	1.00	0.96
Iron oxide	0.85	1.05	0.80
Lime	0.10	0.10	0.05
Magnesia	0.15	0.25	0.30
Alkalies	0.40	0.10	0.31

All quartz rocks or substances high in silica will not make good silica brick. Not only chemical composition, but also physical properties, such as structure, fusibility and action as to expansion during burning, have their effect on the final structure of the brick. Chemically, the quartzites must be high in silica, low in alkalies, but contain enough fluxing impurity to give the brick produced a bond. This impurity is usually an alumina and iron oxide content. The composition should range between 96 and 98 per cent silica, 7.75 to 2.5 per cent alumina and iron oxide, very little lime and magnesia and less than 0.5 per cent alkalies.

Melting Point of Quartzite

The melting point of quartzite will depend to a certain extent on the composition and accessory minerals. With increase in bases, the melting point decreases. Pure quartzite has a higher melting point than the quartzites used commercially, but does not produce a good sound brick and will not have the physical strength required in metallurgical work. The melting or softening point varies from 3290 to 3360 degrees Fahr. Good quartzites must have a high melting point, although those having the highest will not make the best brick.

The structure of the rock is of considerable importance. The quartzites used in this country are hard, splintery rocks which break down to angular fragments having no rounded grains. Sandstones of equal purity chemically, because of the roundness of the grain, cannot be used in the production of brick.

Probably the most important test on a quartzite is the expansion on

Presented at the Boston meeting of the American Foundrymen's association.

heating. The permanent expansion may take place largely in the first burn, and to a very small extent in successive burns. The purer quartzites show high expansion or nearly complete expansion in the first burns and relatively little expansion on succeeding burns. The impurer quartzites require somewhat longer time in coming to complete expansion, while the impure sandstones, quartz-schists, etc., show a low expansion on the first burn, and increasing expansion in successive burns. Such results would indicate that, if we could use the purest quartzites and burn them to a high temperature and hold them there until expansion was complete, we would not be troubled with permanent expansion on brick after they have been placed in the furnace. The transformations which occur in the furnace wall after it has been built would then take place in the kiln of brick which is being held at a high temperature, and the only expansion which would occur would be the temporary thermal expansion. Study with the microscope has shown such expansion to be due to a transformation in the form of the silica from quartz to cristobalite. The transformation occurs largely in the first burn, to some extent in the second and less or not at all in the third.

Accompanying Physical Changes

A brick of 100 per cent quartz on conversion to cristobalite would suffer an increase in volume of 13.6 per cent. However, although the reaction in a silica brick indicates the development of cristobalite, not cristobalite but tridymite is the stable form of silica at the temperature at which silica brick are used. Tridymite develops from the cristobalite on repeated heating of the brick and is a much slower conversion than quartz to cristobalite. The conversion of quartz to cristobalite is accompanied by a volume increase of 13.6 per cent and quartz to tridymite of 16.7 per cent. From this fact one sees that even after a maximum development of cristobalite, when the tridymite begins to form, there will be an increase in volume. Holding the temperature in burning at a maximum for several weeks instead of two or three days would probably increase the development of cristobalite and produce some tridymite.

All processes of manufacture of silica brick are fundamentally the same, differing only in the execution of certain steps in the process. In general, it is a grinding, mixing, forming, drying and burning process. The older methods included semi-drying, re-pressing and then complete drying. Recently, however, by working the batch stiffer, repressing has been eliminated. The consistency is such that the brick retain their shapes after being dumped from the molds, and they can be dried completely without repressing.

The method of winning raw material will depend to a large extent upon its occurrence. In places where the quartzite occurs as a talus it is only necessary to break the pieces to a size which can be handled and to transport them to the plant. Where the raw quartzite is quarried, the usual quarrying methods are used and the material loaded onto cars. Some plants are located a considerable distance from the quarry, and in this case shipment is made in freight cars. At the plant it is dumped from a trestle, either directly into the jaw crusher, if it is to be used at once, or into a storage bin and then into the crusher. Great precaution is exercised in the selection of this raw material. The crusher used is the ordinary jaw crusher; it crushes the raw quartzite to pieces about two cubic inches in size. From here it is elevated, dropped into a steel hopper over a wet pan and is ready to feed into the pan for further grinding and mixing with lime. The wet pans are 7 to 9 feet in diameter and operate periodically, one charge being enough for 150 to 300 standard brick. Sufficient water is added to give the mass molding qualities, and in this water milk of lime is suspended to such a concentration as will add 2 per cent lime to the bath. The purpose of the lime addition is to give the brick a bond in the burned state. A greater amount of lime decreases the resistance of the brick to abrasion, and less lime makes it friable and crumbly to the fingers. High lime also decreases the refractoriness of the finished brick. The degree of fineness will depend upon the time of grinding. This will depend upon whether the batch is to be used in special shape or standard brick work. Because of the difficult shapes made, the special shape batch must be ground finer or longer than the standard brick batch. At the previously mentioned plant the time of one grinding is approximately 15 minutes for standard brick. This may be increased to 25 or 30 minutes for special shapes.

The charge is removed from the wet pan by an automatic plow, which is lowered into the pan, scoops up the material and throws it over the side. Here it is either caught in a cart conveyor, or thrown onto a molding table or belt conveyor. In one plant the batch is elevated to large steel tanks where it comes down directly over the molding tables. Other plants transport the wet batch in dump cars to the floors on which the molding is to be done. At one plant part of it is trucked to the molding room after being elevated to a bin, and the rest is elevated and conveyed to the second floor where special shapes are produced. Here the shapes are made and dried on the hot floor. Molding the ware is done by hand. The batch is worked stiff, rammed into steel molds with pneumatic hammers or by hand, then inverted onto a pallet and the outside molds stripped off leaving the brick on the pallet. From two to 10 brick are made in one mold. The molds are made of steel and can easily be taken apart and put together. The brick are then placed on cars and pushed into drying tunnels through which they travel progressively. It takes from three to five days for the brick to pass through such a tunnel and during this time drying takes place. The tunnels are heated in various ways. A common method is to use the waste heat from cooling kilns. Air is drawn through the kiln, being cooled, passed down through large flues up into one end of the tunnel, through the tunnel and exhausted at the other end. Another method is to use the waste steam from a steam engine during working hours and live steam at night. Special shapes are dried on drying floors instead of the tunnels, owing to the variety of shapes. From here they are wheeled to the kiln.

Method of Burning

The brick should leave the dryer completely dried and very sound. They are then taken by cars to the kiln and set for burning. The kilns are round or rectangular. Soft coal is used for fuel. The burning to a maximum should be done very slowly, as rapid burning produces a shattering of the silicious material, and the development of cracks and fissures in the quartzite. An abnormal expansion which would simulate a true expansion could occur here by rapid heating, but the bricks would fail in any abrasive tests to which they might be subjected. Burning is continued slowly for seven or eight days, then the temperature held for 24 to 48 hours. Then the fires are drawn and the fireplaces sealed for 48 hours. After that one or two and finally all are opened. The whole cooling process requires eight to 10 days. The cooling is just as important and requires as much or more care in producing a ware free from strains as the burning. From the kiln the bricks are taken either directly to the shipping platform or to the warehouse. Warehouses or

storage rooms should be completely covered, free from water, and the brick fully protected from the action of the weather.

Of primary importance in the physical properties of silica brick are its resistance to abrasion, cross-breaking strength, strength of compression, its thermal conductivity, refractoriness, load-carrying capacity at high temperature, and finally the amount of its permanent expansion after the first burning.

Resistance to abrasion can be determined by a modified sand-blast or rattler test. The rattler test as applied to paving brick has been especially successful. The rattler consists of a 14-sided steel barrel in which 10 standard brick and 300 pounds of spherical shot are placed and the whole rotated 1800 revolutions. The loss in weight of the brick is the criterion of the test. At the present time all the large cities and municipalities buy brick based entirely on their action in the rattler. A similar standardized test on fire brick required of the seller by the purchaser would certainly help in determining those brick which showed high resistance to abrasion.

Cross-breaking and crushing-strength tests have been used by various investigators in following the change in strength in a brick after different processes that the brick have been put through. In the cross-breaking test the brick are laid edgewise over a span of 6 inches and loaded at the center. The crushing strength is determined on a flat piece bedded firmly in a crushing-strength machine. McDowell gives values for a regular grind brick of one burn of 700 to 900 pounds per square inch modulus of rupture; and crushing strength, 2100 to 2700 pounds per square inch. For an Illinois fire brick, Harvard gives the crushing strength on the side as 2345 pounds per square inch; on the edge, 1546 pounds per square inch, and on the end 2119 pounds per square inch.

Load-Carrying Capacity at High Temperature

Silica brick or any refractory brick which bear heavy loads at high temperatures should have high compressive strength at these temperatures. For fireclay brick such a test has been accurately worked out by Bleininger and Brown and will be described later. Silica brick tested by Brown in the same way showed excellent resisting qualities. A sample brick standing on end, subjected to a load of 50 pounds per square inch, held at 2460 degrees Fahr. for one hour, showed no change. In another test the brick was subjected to a load of 50 pounds per square inch at 2680 degrees Fahr. without being affected. Other specifications than those used for fire brick could be made for silica brick. Such tests would be useful in bringing out the relative value of the various kinds of brick and in showing how these brick would act in a structure where they must carry a high load at high temperatures.

The thermal conductivity of silica brick is very low. In some structures this is an advantage, in others a decided disadvantage. Magnesite brick are better heat conductors. For certain purposes, as in coke oven work, any treatment which will increase the conductivity of silica brick would be valuable. In other operations the conductivity should be small, and those brick having a low conductivity should be used. Brown showed that silica brick had 8.99 per cent higher conductivity than clay brick. The state of division of material in the brick, the number of pores, the burning treatment and the composition all influence the conductivity.

Expansion of Silica Brick

Silica brick on heating have a linear expansion due to the increase in temperature. Besides this increase in expansion, however, there is a permanent expansion due to a change in state in the raw material. This was previously discussed under the properties of raw quartzite. The linear expansion is entirely distinct from the permanent expansion and should be considered in any application of silica brick. It varies from 3.0 to 4.5 per cent. Bleininger showed that permanent expansion increases directly with the temperature; it does not coincide with the development of cristobalite. He suggests cones 18 to 20 as the minimum burning temperature for silica brick. It would seem that the complete development of tridymite in the brick as the stable phase is impractical for the manufacturer of silica brick. However, whatever this permanent expansion is, it should be known and allowance made for it when the brick are placed in a furnace wall.

The rate of heating has a great influence on the structure of the brick. Rapid heating will produce abnormal expansion, but the brick will not be sound. Disintegration of the body results and the resisting quality of the brick will be reduced. This is directly connected with the spalling tendency of a brick. Spalling is a breaking down of the brick structure due to too rapid changes of temperature. Although the only external evidence of spalling is the splitting off of pieces, still there is considerable effect on the internal structure. McDowell showed such a result by heating the brick slowly, then cooling rapidly, but not so rapidly as to cause parts of the outside to break off. The cross-breaking strength on such treatment fell off considerably. Brick before being used should be tested for this property and those brick selected for use which offer the most resistance to spalling.

The Uses of Silica Brick

Because of its refractoriness and absence of the tendency to shrink, silica brick, wherever possible, are displacing high grade fire brick. They cannot be used in places of sudden heating and cooling, because too rapid changes of temperature will weaken the material. In open hearths, coke ovens, acid converters, crucible furnaces and heating furnaces, silica brick have found wide uses. In basic open-hearth work, silica brick are used above the slag line and for the roof. Due to the lack of shrinkage it is possible to construct roof and crowns of silica brick which will keep tight and also possess refractoriness. Kelley speaks of their use in steel converters as a first lining over which a 3-inch course of ganister is placed. This ganister is very refractory; the lining has given as high as 18 months' service. Silica brick have replaced clay brick in the crucible steel melting furnaces so favorably that linings which formerly lasted four to six months are now used for as high as 40 months and have an average life of 14 to 18 months. He also states that silica brick are used exclusively in electric furnaces except where magnesia brick are employed on account of the basic character of the slag. He considers the temperature in this furnace higher than in any other operation and the refractoriness required of the lining greater.

In the open hearths, silica brick are being used wherever possible. In the basic process, magnesia brick are used for the linings in contact with slag and metal, but above the slag line and in the roof silica brick are used to the greatest extent. In the basic process the bottoms and part of the sides are made of magnesite brick and fused magnesite; between the top of the magnesite and the bottom of the silica a buffer layer of refractory chrome brick is used. In the acid type, silica brick are used for the bottom and covered with fritted sand.

The acid bessemer converter has a silica lining of silica brick, but in the basic process the complete lining is of magnesite and magnesite brick.

The most common materials used in basic and neutral refractories are the crystalline or amorphous mineral magnesite and dolomite. Other magnesian minerals have been used alone and in combination with fire clays as a heat resister for years. The various forms of asbestos, serpentines, steatites and soapstones have been used. The melting points of both lime and magnesia are very high; Harvard gives values for magnesia as high as 4532 degrees Fahr. where it forms a viscous mass. Rankin and Wright estimate the melting point of lime at 4660 degrees Fahr.

The use of lime alone as a refractory has not been successful, partly because of its affinity for moisture and because of the formation of calcium salts of iron. Judging from its refractoriness alone, it could make as equally valuable a refractory as the magnesia.

Official Pig Iron and Steel Scrap Prices Revised

Some important changes have been made in the differential list of government pig iron prices, which apply to high silicon bessemer iron, charcoal iron, silveries and copper-free and copper-bearing low phosphorus grades. Rulings on the sale of low phosphorus steel scrap also have been made, that clear up this complex situation. The statement issued by Chairman E. H. Gary of the committee on steel and steel products of the American Iron and Steel institute, regarding pig iron and scrap, follows:

Pig Iron

The base price of $33 per gross ton f. o. b.* furnace applies from and after April 1, 1918, to No. 2 foundry pig iron only.

Basic iron, $1 below base price.

Bessemer iron up to 3 per cent silicon, 10 per cent above price of basic.

For bessemer irons over 3 per cent silicon:

	Gross ton
3 to 3½ per cent silicon add.....	$2.00
3½ to 4 per cent silicon add.....	3.00
4 to 4½ per cent silicon add.....	4.00
4½ to 5 per cent silicon add.....	5.00

Above extras for high silicon bessemer iron are to be added to the base price of bessemer iron not exceeding 3 per cent in silicon.

Charcoal Iron

Southern or warm blast charcoal iron, ranging from 0.40 to 0.60 phosphorus.

For silicon up to 2 per cent, a maximum of $10 per gross ton over base.

For silicon over 2 per cent, add to above differential $1 for each ½ per cent of silicon above 2 per cent.

Cold blast charcoal iron, a maximum of $47 per gross ton above base, with customary reductions for lower grades, as recognized by the trade.

Northern semi-cold blast iron, a maximum of $22 per gross ton above base.

Lake Superior iron, $2.50 per gross ton above base for iron averaging 1.25 per cent in silicon. Other grades to be adjusted as per the custom of the trade, depending upon the silicon, phosphorus and manganese contents of the iron.

All of these charcoal iron differentials to be considered in connection with the base price.

High Silicon or Silvery Iron

For iron containing:	Gross tons
6 per cent silicon.....	$8.00 above base
7 per cent silicon.....	10.00 above base
8 per cent silicon.....	12.50 above base
9 per cent silicon.....	14.50 above base
10 per cent silicon.....	17.00 above base

Three dollars per gross ton advance for each 1 per cent silicon for 11 per cent and over.

Low Phosphorus Iron

Iron containing phosphorus and sulphur not exceeding 0.04 and silicon not exceeding 2 per cent.

	Above base
For copper free iron, copper not exceeding 0.04	$20.00
For copper bearing iron, copper not exceeding 0.25	19.00
For copper bearing iron, copper not exceeding 0.50	18.00
For copper bearing iron, copper over 0.50	17.00

A sliding scale of $1.50 per gross ton advance for each reduction in phosphorus of 0.005 per cent below 0.04 and $1.75 per gross ton advance for each 1 per cent silicon in excess of 2 per cent.

For iron with phosphorus over 0.04 use following scale:

	—Add to base price per gross ton—			
Phosphorus, maximum	Copper 0.04 maximum	Copper 0.25 maximum	Copper 0.50 maximum	Copper over 0.50
0.040	$20.00	$19.00	$18.00	$17.00
0.045	17.50	16.50	15.75	15.00
0.050	15.00	14.25	13.50	13.00
0.055	12.50	12.00	11.50	11.00
0.060	10.00	9.50	9.25	9.00
0.065	6.50	6.50	6.50	6.50
0.070	5.50	5.50	5.50	5.50
0.075	5.00	5.00	5.00	5.00
0.075-0.09	———(Use bessemer price)———			

Other extras and differentials on pig iron remain as shown in the institute pamphlet of January, 1918.

IRON AND STEEL SCRAP

The committee approves of and announces rulings of the subcommittee on scrap iron and steel as follows:

Low phosphorus steel scrap may only be dealt in under Schedule 2 (a) when it consists of material specifically named therein.

Shell steel scrap, ship-plate shearings and all other low phosphorus scrap, 0.04 and under in phosphorus and sulphur, must be sold under Schedule 2 (b), maximum $36.50.

Schedule 2 (c) may not be abused by the shipment of melting steel scrap to an acid or electric furnace. It shall consist only of low-phosphorus material which will not analyze 0.04 and under in phosphorus and sulphur and must be of a character similar to the material specified therein.

Low phosphorus turnings, including shell steel turnings, may not be dealt in at any price in excess of that announced under Schedule 9.

Shell steel turnings, may only be sold under Schedule 9 (b), maximum $24, when the heavy cuts have been separated to conform with that schedule.

No charge for shearing or otherwise preparing scrap may be added to any of the differentials announced.

Pettinos Bros. Dissolve, But Principals Continue in Business

The firm of Pettinos Bros., New York, manufacturer of foundry facings and dealer in foundry sand and supplies, has been dissolved and the business of this firm will continue to be conducted by Charles E. Pettinos.

George F. Pettinos announces that he also will continue in business as a producer of foundry facings, shipper of sand and dealer in foundry supplies, with headquarters in the Real Estate Trust building, Philadelphia.

The Measure of Deflection

By W. J. Keep

Question:—We would like to know what method is pursued for determining the deflection of cast iron bars, 1 inch square, for transverse tests.

Answer:—You can improvise an arm which will multiply the deflection enough so that you can read it. Write to the makers of your testing machine and ask them if they make such a measurer for deflection. The usual arrangement is a stand which sets on a level table under the center of the test bar. On this stand is a bearing for a pointer with a short arm which rests on the under side of the test bar, while the outer arm is 10 times as long and readings are taken from a graduated arc at the outer end of the arm or pointer. It is difficult to make an autographic recorder of deflection for test bars, 1 inch square and 12 inches between supports, for the reason that the deflection is very small and the load is very great. If you use a 1-inch bar, 24 inches long or ½ inch square and 12 inches long, you will have no trouble.

Compounding Mill Made Big Record

In the April issue of THE FOUNDRY, page 169, was published an article by R. E. Kennedy, entitled "Producing Small Cores Cheaply in Quantities". One page 174 is contained a table giving comparative core sand mixture costs when using a compounding mill to facilitate the addition of gangway sand and also the cost when not using the mill. The cost of compounding the sand with the mill is given as 62 cents per ton and without the mill, $1.47 per ton. This mill, however, is of an entirely different type than the sand mixer shown in Fig. 2 of this article, page 170, and concerning which reference is made immediately following this table on page 174. The reference is somewhat confusing and to avoid any possible error regarding the equipment which made the enviable record shown by the table, this explanation is offered.

A Simple Foundry Cost and Accounting System

Method Introduced in the Foundry Department of the Worcester Polytechnic Institute, Which Involves No Increase in the Clerical Force

By William W Bird

THE work in shop management at the Worcester Polytechnic institute, Worcester, Mass., is in the nature of a laboratory course, and experimental work in accounting and cost keeping is made possible by the commercial foundry and machine shop of the institute, known as the Washburn shops. The object of this paper is to present an outline of the cost and accounting system which has been developed as a result of experiments carried on in connection with the foundry at the institute.

The first problem was to determine the number of independent variables and how the dependent ones were related to them. After several years it was decided that the three most important items were core labor, molding labor and pounds of castings produced, and that each of the other items of cost was a function of some one of these three independent items.

Ledger accounts were opened for each of the items, and by careful inventories at the beginning and end of each year the exact annual cost for each item was worked out.

The next problem was to determine a proper production credit for the individual accounts for each month, based on factors secured by previous records. The general scheme is to charge an account with the amount of the purchases for that month and credit it with a fair estimate of what ought to have been used for that month's work. These production credits are charged to another account, as will be explained later.

All expenses are charged to the expense account and the production credit for expense ought to be large enough to more than balance the charges, thus creating a balance known as expense reserve.

The material required for core work was found to average about 30 per cent of the core labor, hence to make the production credit for core work for a month it was only necessary to secure from the payrolls the amount paid to the coremakers for that month and add 30 per cent for the supplies used.

All of the items of cost in the foundry except the metal, melting and core work, were divided into two classes: Supplies or all the materials used in connection with molding, such as sand, facing, etc., and expense, or all charges for management, office work, power and other overhead items, cleaning, flasks, etc. At present we are basing our production credits for supplies on 6 per cent of the molding labor and the expense on 75 per cent, the molding labor for the month being secured from the payrolls, all of the molders being grouped for this purpose.

To secure the exact tonnage for each month it was found necessary to make an inventory on the first of each month of the castings on hand. This, however, is only a close estimate of the weight of these castings. A record of the castings sold during the month gives the tonnage also. Correcting this for the change in the inventory of castings, gives the production in pounds for the month.

Cost of Melting

The cost of melting was found to vary directly with the pounds of castings produced and, therefore, the melting production credit for the castings produced each month is found by multiplying the pounds produced by the melting factor, which at present is 30 cents per 100 pounds.

A careful record for a number of years of the castings produced and of the pig and scrap used, gives the data for the factors to be employed in making up the production credits for the metal used each month. At present we use 75 per cent of the pounds produced as the proper weight of pig iron, and 37½ per cent for scrap iron. These factors take care of the shrinkage and the defective castings, as these are replaced without credit to the foundry.

Knowing the weight and cost of the pig iron purchased each month, the cost, including all charges for freight and teaming, 100 pounds is made up. Multiplying this by 75 per cent of the pounds produced, we have the production credit for pig iron. The production credit for scrap iron is worked out in the same way.

The problem of handling the difference between the material purchased and what was actually used was solved by making the ledger balance a book inventory for material accounts and a reserve for the expense account.

The next problem of how to adjust the difference between the castings sold and the castings produced was solved as follows:

Two ledger accounts were opened, *foundry sales* and *foundry production.* The first is credited with the monthly sales and charged with the factor cost of the castings sold. The balance of this account is the factor gain and gives a definite line on the profits.

Foundry production is charged each month with the total amount of the production credits and credited with the factor cost of the castings sold, the monthly ledger balance giving the value of the castings on hand. In fact, the value of the castings on hand is worked up first from the inventory made on the first of each month, and the factor cost of castings sold is simply the amount required to make the account show the proper balance.

To show the exact working of this system, the figures for three months will be given—a good month, a fair month, and a poor one. As these months did not come in this exact order, it was necessary to make a few changes in the figures, but they are substantially an exact record.

Starting with a clear record on July 1, with no castings on hand, we have:

BALANCE SHEET, JULY 1

ASSETS

Bills receivable	$13,187.20
Cash	6,331.06
Metal and supplies	1,333.03
Equipment	5,000.00
	$25,851.29

LIABILITIES

Capital	$20,000.00
Surplus	3,654.13
Bills payable	2,197.16
	$25,851.29

The inventory on Aug. 1 gave 3500 pounds of castings on hand, the sales record gave 122,541 pounds sold, the production was therefore 126,041 pounds. The core labor was $443.89 and the molding labor, $1863.84; 117,180 pounds of pig iron cost $2381.86 and the scrap iron cost $1.50 per hundred pounds delivered in the yard. These are all of the data necessary for making up the monthly foundry record for July as shown in Table I.

The factor cost was $5.52 per 100 pounds for castings produced and the castings on hand at the end of the month were valued at this rate. Thirty-five hundred pounds at $5.52 gives a correction of $193.20. This is the dif-

To be presented at the spring meeting of the American Society of Mechanical Engineers, to be held at Worcester, Mass., June 4 to 7

Table I

Monthly Foundry Record, July

Purchases	Division	Factor, per cent	Production credits
$443.89	Core labor	100	$443.89
127.00	Supplies	30	133.17
1,863.84	Molding labor	100	1,863.84
156.29	Supplies	6	111.83
1,303.03	Expense	75	1,397.88
612.17	Metal—melting, cents	30	378.12
2,381.86	117,180 pounds pig iron	75	1,918.98
737.62	$1.50 per 100 scrap iron	37½	708.98
$7,625.70	Total—Factor cost of production	....	$6,956.69

Table II

Monthly Foundry Record, August

Purchases	Division	Factor, per cent	Production credits
$522.61	Core labor	100	$522.61
45.50	Supplies	30	156.78
1,968.90	Molding labor	100	1,968.90
44.83	Supplies	6	118.13
1,426.64	Expense	75	1,476.67
382.21	Metal—melting, cents	30	399.82
2,759.65	107,620 pounds pig iron	75	2,568.84
701.70	$1.75 per 100 scrap iron	37½	874.62
$7,852.04	Total—Factor cost of production.	....	$8,086.37
	Inventory correction		$49.60
	Factor cost of castings sold		$8,036.77
	August sales		8,179,51
	Factor gain—August		142.74
	Factor gain—July 1-Aug. 1		586.82
	Factor gain—July 1-Aug. 31		$729.56

Table III

Monthly Foundry Record, September

Purchases	Division	Factor per cent	Production credits
$542.00	Core labor	100	$542.00
65.46	Supplies	30	162.60
2,016.70	Molding labor	100	2,016.70
144.94	Supplies	6	121.00
1,326.58	Expense	75	1,512.53
541.90	Metal—melting, cents	30	406.67
2,834.85	116,980 pounds pig iron	75	2,460.37
1,763.52	$1.75 per 100 scrap iron	37½	889.60
$9,235.95	Total—Factor cost of production.	....	$8,111.47
	Inventory correction		$654.20
	Factor cost of castings sold		$7,457.27
	September sales		7,485.76
	Factor gain—September		28.49
	Factor gain—July 1-Sept. 1		729.56
	Factor gain—July 1-Sept. 30		$758.05

Table IV

Monthly Averages

	Previous year	July	August	September
Production, lb.	138,605.00	126,041.00	133,273.00	135,557.00
No. of heats	24.50	24.00	24.00	25.00
No. of molder days	442.00	467.00	478.00	493.00
Weight per heat, lb.	5,670.00	5,250.00	5,550.00	5.420.00
Weight per molder day	314.00	270.00	279.00	275.00
Cost of molding	$1,644.82	$1,863.84	$1,968.90	$2,016.70
Avg. pay per molder day	3.72	4.00	4.12	4.09
Core work per 100 lbs.	0.42	0.46	0.51	0.52
Molding and expense	2.14	2.68	2.67	2.69
Melting and metal	1.53	2.38	2.89	2.77
Production cost	$4.09	$5.52	$6.07	$5.98
Inventory correction	.....	.....	0.02	0.01
Cost of castings sold	4.09	5.52	6.05	5.99
Selling price	4.36	6.00	6.16	6.01
Factor gain	0.27	0.48	0.11	0.02
Sales total	$6,093.60	$7,350.31	$8,317.51	$7,542.46
Factor gain month	375.46	586.82	142.74	28.49
Per cent gain	6.20	8.00	1.70	0.40
Expense reserve	$35.00	$94.85	$50.03	$185.95
Rating	Good	Good	Fair	Poor

Table V

Inventories—Metal and Supplies

MONTHLY CHANGES

	July	August	Sept.
Core supplies	— 6.17	—111.28	— 97.14
Molding supplies	+ 44.46	— 73.30	+ 23.94
Melting supplies	+234.05	— 17.61	+135.23
Pig iron	+462.88	+190.81	+374.48
Scrap iron	+ 28.64	—172.92	+873.92
Net change	+763.86	—184.30	+1,310.43
Beginning of month	$1,333.03	$2,096.89	$1,912.59
End of month	$2,096.89	$1,912.59	$3,223.02

Table VI

Samples of Ledger Pages

FOUNDRY SALES

July 31	Factor cost—sales	$6,763.49	July 31	Sales	$7,350.31
	Balance	586.82			
		$7,350.31			$7,350.31
			Aug. 1	Balance	586.82

The balance of this account gives the factor gain and is the total amount from the beginning of the fiscal year.

FOUNDRY PRODUCTION

Aug. 1	Balance	$193.20	Aug. 31	Factor cost—sales	$8,036.77
31	Factor cost—production	8,086.37		Balance	242.80
		$8,279.57			$8,279.57
Sept. 1	Balance	242.80			

The balance on this account is the exact inventory of the castings on hand, valued at the factor cost for the month.

FOUNDRY EXPENSE

Sept. 30	Purchases.	$1,326.58	Sept. 1	Balance	$144.88
	Balance	330.83	Sept. 30	Production credits	1,512.53
		$1,657.41			$1,657.41
			Oct. 1	Balance	330.83

The balance on this account is the amount that the reserve has built up during the year.

PIG IRON

July 1	Balance	$331.20	July 31	Production credit	$1,918.98
July 31	Purchases	2,381.86		Balance	794.08
		$2,713.06			$2,713.06
Aug. 1	Balance	794.08			

The balance on this account is the book inventory for the pig iron on hand.

ference in the value of castings on hand at the beginning and end of July, as shown by the following:

Factor cost of production	$6,956.69
Correction	193.20
Factor cost of castings sold	$6,763.49
Sales for July	7,350.31
Factor gain for July	$586.82

The expense reserve is found by subtracting the charges, $1303.03 from the credits, $1397.88, giving $94.85 for the month. The trial balance of the ledger gives the necessary data for the following:

BALANCE SHEET, JULY 31

ASSETS

Bills receivable	$13,288.31
Cash	6,299.50
Castings	193.20
Metal and supplies	2,096.89
Equipment	5,000.00
	$26,877.90

LIABILITIES

Capital	$20,000.00
Surplus	3,654.13
Bills payable	2,542.10
Expense reserve	94.85
Factor gain	586.82
	$26,877.90

On Sept. 1 we had 4000 pounds of castings on hand, and sold in August 132,773 pounds. The production, therefore, was 133,273 pounds, as we had 500 pounds more on hand at the end

of the month than at the beginning. The August foundry record is given in Table II.

The expense reserve for August is $1476.67 minus $1426.64, or $50.03, making the total reserve, Aug. 31, $144.88. The balance sheet for August follows:

BALANCE SHEET AUG. 31

ASSETS

Bills receivable	$14,016.50
Cash	5,750.82
Castings	242.80
Metal and supplies	1,912.59
Equipment	5,000.00
	$26,922.71

LIABILITIES

Capital	$20,000.00
Surplus	3,654.13
Bills payable	2,394.14
Expense reserve	144.88
Factor gain	729.56
	$26,922.71

On Oct. 1 we had 15,000 pounds of castings on hand and sold during September 124,557 pounds. The production for the month, therefore, was 135,557 pounds. The foundry record for September is given in Table III.

The expense reserve for September is $1512.53 minus $1326.58, or $185.95, which added to $144.88 makes the total reserve $330.83. The balance sheet, Sept. 30, follows:

BALANCE SHEET, SEPT. 30

ASSETS

Bills receivable	$13,378.81
Cash	5,374.27
Castings	897.00
Metal and supplies	3,223.02
Equipment	5,000.00
	$27,873.10

LIABILITIES

Capital	$20,000.00
Surplus	3,654.13
Bills payable	3,130.09
Expense reserve	330.83
Factor gain	758.05
	$27,873.10

To keep comparative data before the foundry officials and aid them in the analysis of the monthly records, the table of monthly averages is filled in as soon as possible after the first of each month. This is given in Table IV.

In order to keep a line on the book inventories, the table following that of monthly averages is filled in each month. These figures show the changes in the several accounts and indicate in a way how the factors are working. If an account is steadily growing, as the pig iron account shows in this table, we are either accumulating pig iron or the factor is too small. Core supplies here shows a constantly diminishing amount, and either we are reducing our supplies or the factor is too large. An exact inventory can be made at any time to check up the book inventory and a change made in the factor is necessary.

Samples of ledger pages, Table VI, show how the bookkeeping is done.

Every ledger balance has a definite meaning, either an inventory, a reserve or a gain, and the complete balance sheet for each month can be made up in a few minutes from the regular trial balance. All of the work can be done by the regular clerical force and requires only a small amount of extra time. No expert accountant or efficiency engineer is needed.

Closing the Books

Closing the books at the end of the fiscal year introduces several interesting problems. The molding and core labor accounts take care of themselves as the charges and credits are the same and therefore, they are always balanced. The material accounts are first corrected by introducing the exact value of a carefully made inventory. This gives us the real cost for the material which has been actually used during the year. The next step is to adjust the production credit for the 12 months to the final charge. The difference between the two sides of the ledger is the amount of the adjustment and may be either plus or minus. The net result of all these factor adjustments is carried to expense reserve and will either increase it or decrease it, as the case may be.

Bad accounts, depreciation charges, discounts, premiums, special expenses or any other accounts which need to be absorbed, are all transferred to expense reserve and the net balance of the account is carried to foundry sales, either increasing or decreasing the factor gain and this balance then becomes the real sales gain for the year. The system as outlined is giving satisfaction, the results are fairly accurate, and the comparative monthly data thoroughly reliable as a signal system.

Aircraft Specification for Cast Iron

(*Continued from page* 243)

WORKMANSHIP AND FINISH.—The metal shall be close-grained and uniform in quality. The castings shall be free from cracks, flaws, blowholes, hard spots, spongy spots, excessive shrinkage, and other defects. They shall be well cleaned of gates, risers, and fins, and shall have a smooth surface. Castings must be soft enough to machine readily on all sections. A casting may be rejected at any time because of injurious defects or faults which are revealed by manufacturing operations, notwithstanding that it has previously passed inspection. Such rejected castings shall be returned to the manufacturer at his expense. This clause shall not apply to castings fabricated after export.

PHYSICAL PROPERTIES AND TESTS.—*Springing Test.—(a)* The manufacturer must subject each piston ring to the following springing test. Only rings which withstand this test may be submitted to the inspector. The ring shall be pressed over a cone until the distance between the ends of the ring is equal to seven and one-half times the mean thickness of the ring. Upon removal from the cone the ring must show no set.

Transverse Test.—(b) The test bar supported on knife-edges 12 inches (304.8 mm.) apart and loaded centrally by means of a knife-edge shall show the following properties:

Breaking strength, minimum, 400 pounds (181.8 kg.)

Deflection under load of 350 pounds (159.1 kg.), minimum, 0.15 inch (3.81 mm.)

Hardness Test.—(c) The test bars shall have the following hardness:

Brinell hardness number	200 to 240
Shore scleroscope hardness number	33 to 40

Hardness tests may also be made on castings selected at random and must conform to the requirement specified.

SELECTION OF TEST SPECIMENS.—*(a)* At least 25 per cent of the piston rings submitted at any one time shall be subjected to springing test.

(b) For all castings other than piston rings test bars shall be cast of the same metal and under the same conditions as the castings they represent. The test bars shall be 0.5 inch (12.7 mm.) square and 14 inches (355.6 mm.) long, and shall have identification marks such as a serial number and date cast on them. One test bar shall be required for each lot of 250 castings or less.

(c) Samples for chemical analysis shall be taken from the test bars, but may also be taken from any casting chosen at random. In the case of piston rings the samples shall be taken from the rings.

DIMENSIONS AND TOLERANCES.—The castings must conform to the drawings, and surfaces which are to be machined shall admit of finishing to the required dimensions without leaving evidence of the cast surface.

PACKING, SHIPPING, AND DELIVERY.—*(a)* The melt number or date of casting shall be cast on each casting.

(b) Castings shall be packed in boxes in such manner as to insure against breakage or injury to finished surfaces.

How to Cast a Tube Straight

By W. J. Keep.

Question:—What should we do to make a casting come straight that is 14 feet long, 17 inches outside diameter, 2 inches thick at the top of its entire length and which is gradually decreased in thickness to 1¼ inches at the lower side? Can it be peaned straight?

Answer:—To straighten a casting of this kind support it on bearings near the ends with the crown side up, pile pig iron on the center and build a fire underneath it, its entire length. This will expand the short side and if heated to a sufficiently high temperature it will remain straight when cold. Laying a straight edge on the top surface will enable you to ascertain when the process has gone sufficiently far and this can be determined after a few trials. However, you cannot straighten the pipe by peaning. The essential feature, however, is to prevent making a crooked casting and we suggest that the pattern and core be bent in a direction opposite to that of the bend in the casting. It is fairly certain that this curved pattern will produce straight pipes in most cases.

Gray Iron Foundry Designed to Save Manpower

In the New Plant of the Lakey Foundry & Machine Co. the Equipment is Arranged to Conserve Labor and to Increase Production

FOR years close students of the foundry industry have been concerned over the constantly diminishing supply of skilled labor. Although this situation was unsatisfactory prior to the war, there was little danger of it becoming serious so long as normal conditions prevailed. Trade schools have been established all over the country and other measures have been taken to increase the supply of skilled foundry workmen, both actually and relatively. The war with Germany, however, has upset all previous calculations. Thousands of men have been drawn into the army and navy and other thousands into shipbuilding and other direct war activities. At the same time, immigration has been absolutely cut off. The result has been a marked decrease in the supply of labor of all degrees of proficiency at a time when the demands on foundries for increased production are daily becoming more insistent.

The only probable relief is in the efforts that are being made in almost every shop to utilize labor-saving equipment more extensively and more efficiently. But in an existing plant designed for operation under normal conditions there is a limit to the progress which can be made in this direction, and when this limit is reached extensive changes in the general layout and arrangement of the plant become necessary in order to realize further economies.

Designed for Labor Saving

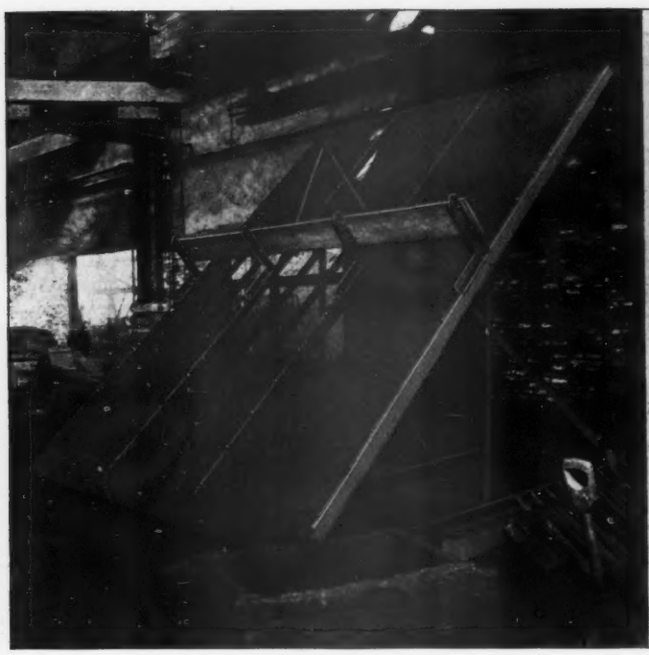
It is profitable, therefore, to study the design and equipment of new plants that have been built in the past few months with a full realization of existing conditions. An interesting shop of this character has recently been completed at Muskegon, Mich., by the Lakey Foundry & Machine Co. It is designed primarily for the production of cylinders and other gray iron automobile castings, but the methods that have been adopted can be applied to many other gray iron foundries.

This plant was built during 1917, largely according to designs prepared by H. A. Becker, president of the Lakey company. In working out the various features of the shop, Mr. Becker constantly kept the existing and probable future labor situation in mind, with the result that the shop is unusually well equipped with labor-saving machinery and, in addition, the departments are so arranged and the work so routed through the plant that the amount of manual labor required, both skilled and unskilled, is reduced to a minimum.

The plant has an output of 65 tons of gray iron automobile and military truck castings per day. It is located on the Lake Michigan waterfront, partly on made ground, on a site that has been the property of the Lakey company for a great many years. The property includes about nine acres, of which 5½ represents filled-in lakeshore land. About 425 men are employed.

The building is a brick and steel structure with ordinary lean-to roofs over the side bays and a trough-type roof over the center bays. This arrangement secures abundance of natural light. A floor plan showing the general arrangement of the building, together with the crane equipment and location of the principal departments is presented in Fig. 6. A typical cross-section showing the roof structure, charging floor and

FIG. 1—A SPECIAL DEPARTMENT IS SET ASIDE FOR CYLINDER MOLDING. CHUTES, *S*, DELIVER THE SAND TO THE MOLDERS' STATIONS. THE FINISHED MOLDS ARE SET ON HORSES



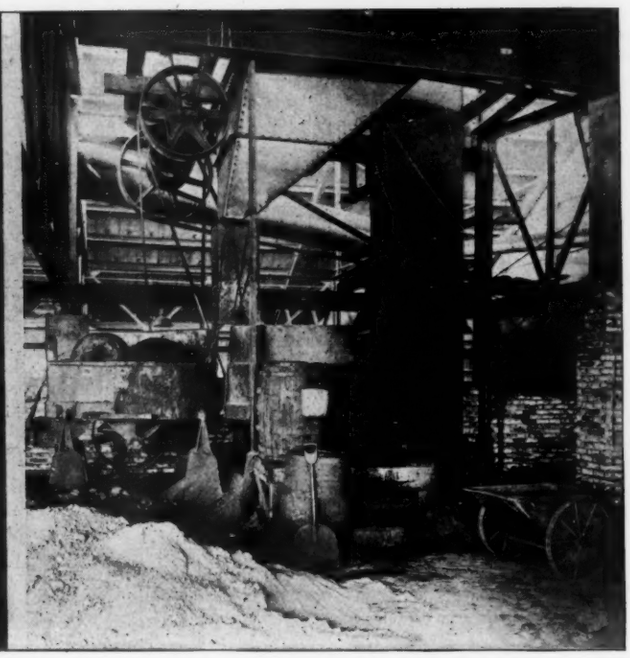


FIG. 2—ALL THE FLASKS ARE SHAKEN OUT OVER A SCREEN WHICH SEPARATES THE SAND FROM THE CASTINGS.
FIG. 3—SAND MIXING APPARATUS ON MEZZANINE FLOOR

crane and monorail runways is shown in Fig. 16. The building is 310 feet long and 200 feet wide. The cleaning room, which extends clear across one end, is 50 feet wide and 200 feet long; it is separated from the rest of the foundry by a brick partition. The foundry proper, therefore, is 260 feet long and 200 feet wide. As shown in Figs. 6 and 16, it is divided into five parallel bays, including a cylinder molding bay, under the charging floor, 50 feet wide; a mold oven and cupola bay, 20 feet wide; cylinder-pouring bay, 50 feet wide; miscellaneous molding and pouring bay, 50 feet wide; and a coremaking bay, also 50 feet wide. The steelwork was fabricated by the Lackawanna Bridge Co., Buffalo, and the building was erected by the National Construction Co., Detroit.

The plant has been carefully laid-out to conform to a certain definite scheme of operations. By studying Fig. 6 it will be noted that the cylinder molding machines are arranged along the west side of the building under the sand spouts. As the molds are finished they are first skidded on horses and then transferred on portable tracks to the drying ovens. These are double-ended and are arranged to discharge directly onto the pouring floor. The cores are made in the east bay and move across the north end of the shop to the assembling department, where they join the molds. Between the pouring and coremaking bays is a 50-foot bay set aside for molding flywheels, pistons, manifolds and other miscellaneous work. The

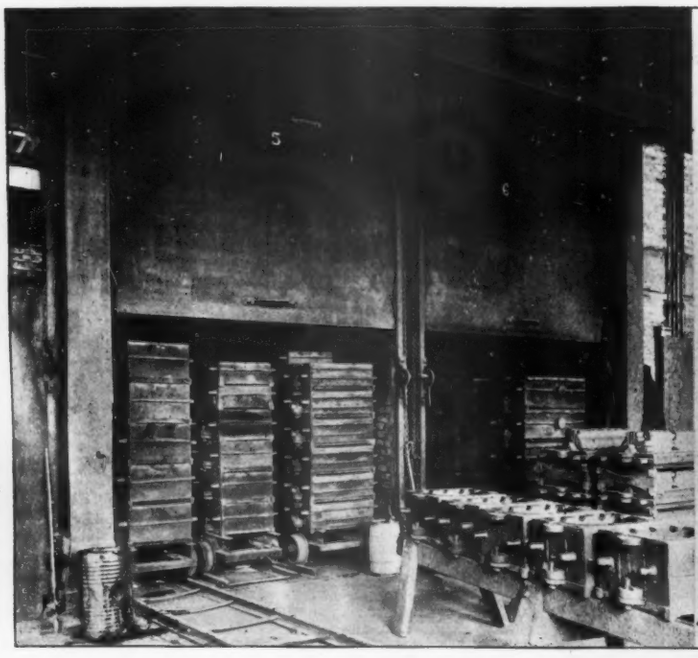


FIG. 4—MOLD-DRYING OVENS SHOWING TYPE OF CARS, PORTABLE TRACKS AND HORSES FOR RECEIVING FRESHLY MADE MOLDS. FIG. 5—A SPECIALLY-TRAINED GANG OF MEN IS EMPLOYED FOR ASSEMBLING THE CORES IN THE MOLDS

flasks are shaken-out over a grating at the south end of the pouring bay, from which the castings proceed direct to the cleaning room extending across the south end of the shop.

There is a basement under the two outside bays with a connecting passage at the north end of the building. This provides for the storage of both molding and core sand and also for mixing and preparing the latter, in addition to other auxiliary operations

The charging floor extends the full length of the shop. The coke, pig iron and scrap are brought up on special elevators at the north end. The used molding sand, together with the proper quantity of new sand, also is elevated to this floor, where it is prepared and returned to the molders through chutes over the molding machines, as shown in Fig. 6 and at *S*, Fig. 1.

The thorough manner in which the various production operations are coordinated is suggested in the foregoing paragraphs. To further unify the work and reduce labor costs, a comprehensive crane and trolley system has been provided for handling materials and work in process of manufacture.

The cylinder molding bay is served by a 2-ton Shaw crane with a span of 27 feet. Two 5-ton Shaw cranes serve the pouring bay and cupolas. They have a span of 48 feet. A runway is provided in the miscellaneous molding bay, but the cranes have not yet been delivered. A 12-inch I-beam monorail serves all portions of the shop, as indicated in Fig. 6. It is extensively employed and relieves the traveling cranes of a considerable burden. Two Shaw electrically operated telphers are provided for the monorail. Elevators, skids, portable track and belt conveyors, which will be described more in detail later, also are provided for handling materials. In every direction an effort has been made to save manpower.

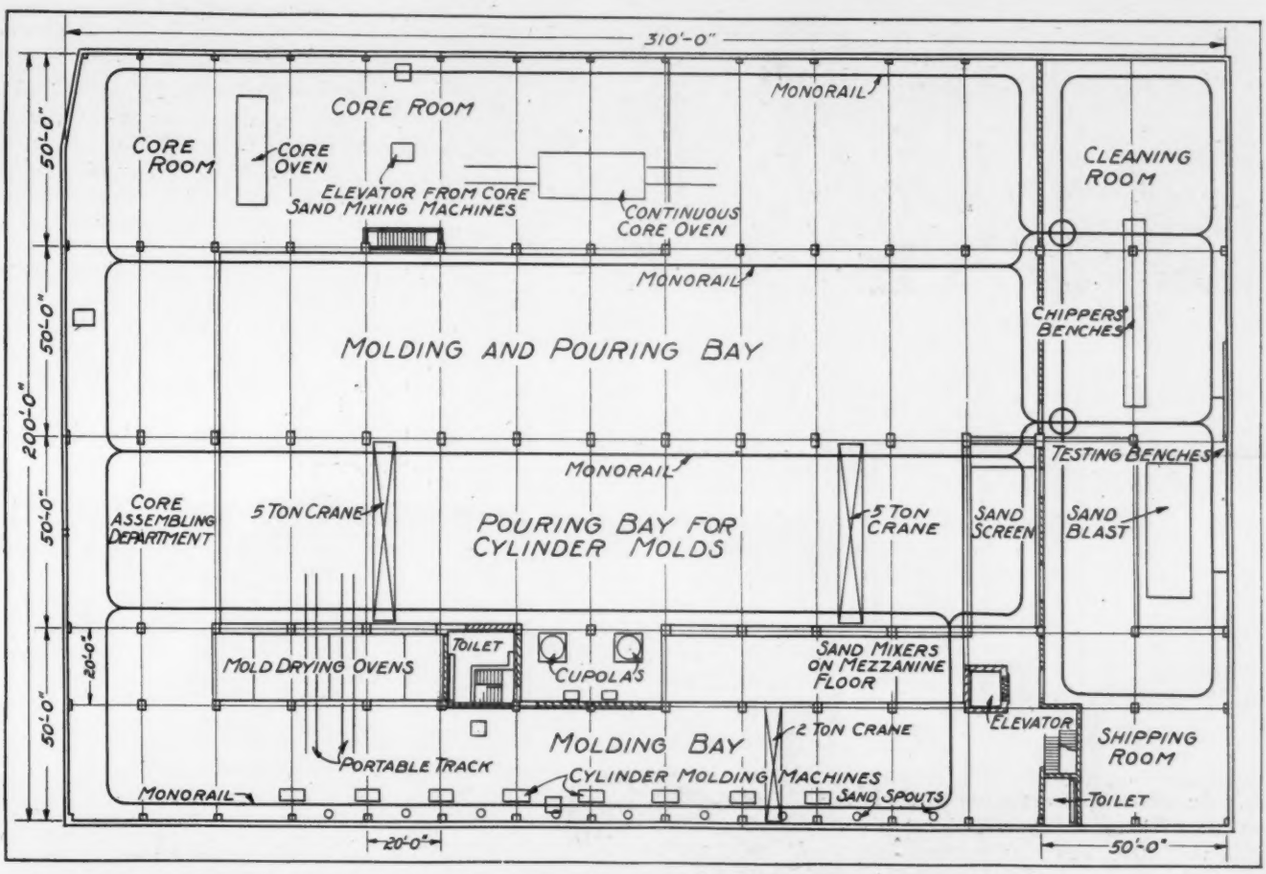


FIG. 6—PLAN OF LAKEY FOUNDRY SHOWING GENERAL LAYOUT OF SHOP AND ARRANGEMENT OF DEPARTMENTS

The arrangements for handling and preparing the molding sand are exceedingly interesting. The sand is handled mechanically, but at the same excessive outlay for equipment has been avoided. No effort is made to rush the sand through the system and ample time is allowed for the sand to season before it is used again.

The flasks to be shaken-out are picked up by the crane and carried to the shaking-out station at the south end of the pouring bay. The location of this station is shown in Fig. 6. A large inclined screen, somewhat similar to a plasterer's screen, is provided at this point for separating the sand from the castings. This screen, which is shown in Fig. 2, is 12 x 16 feet, with a ¼-inch mesh. It is set at an angle of 45 degrees. As the flasks are shaken-out, the fine sand passes through the screen while the castings, with their sprues attached, roll down to the floor at the foot of the screen. Nails, gaggers, etc., also roll down with the castings. In fact, the Lakey company has found it unnecessary to employ a magnetic separator after the sand passes through this screen. The device is exceedingly simple, but in practical use it has proved effective for separating the sand from the castings. There is a grating in the floor under the screen through which the sand falls to bins in the basement. From these bins the used sand passes into the boot of a bucket elevator, which hoists it to the mixing station located on the charging floor. This station is shown in Fig. 3. The bucket elevator may be seen at the right together with the sand hopper into which it discharges. The new sand which is added to the mixture, is shown on the floor in front of the mullers. Two mixers of the Simpson type built by the National Engineering Co., Chicago, have been provided. Their general arrangement is clearly illustrated in Fig. 3. The chute from the sand hopper is so arranged that

the sand may be discharged into either mixer.

The prepared sand is discharged into 2-wheel buggies, one of which is shown at the extreme right in Fig. 3. These buggies are used to transfer the sand to the spouts leading to the molders' stations in the molding room underneath the charging floor. One of these spouts

FIG. 7—A PART OF THE CYLINDER POURING FLOOR SHOWING 3-PART FLASKS CLOSED AND CLAMPED

is shown at *S* in Fig. 1, and their general arrangement is indicated in Fig. 6. The spouts discharge the sand onto the floor beside the molding machines, from which it is shoveled into the flasks. It will be noted that the entire sand-handling arrangement is relatively simple. An effort has been made to avoid the use of long conveyors and complicated machinery, and at the same time to provide adequate facilities for handling the sand economically and preparing it efficiently.

How Cylinders are Molded

The general arrangement of the cylinder molding department is shown in Fig. 1. At the present time, practically all automobile cylinders are molded according to a standardized method, in 3-part flasks with the tops of the cylinders in the drag. Separate machines usually are provided for molding the drags, cheeks and copes. Experience has shown that all of the molds must be dried and for this purpose extensive oven equipment is necessary. After the molds are made and dried, the cores must be set. This is perhaps the most important operation in a cylinder foundry. The cores are assembled in the drags, the work being done by a specially organized gang of men who are thoroughly trained.

At the Lakey plant four gangs of men co-operate in making cylinder molds and preparing them for pouring. The flasks are rammed-up and the molds formed by a gang of specially trained operators working on the molding machines. Both stripping-plate and rockover machines are employed, the former being used for molding drags and the latter for making the cheeks and copes. Pridmore, International and Osborn machines have been installed in the Lakey plant. Some of the machines for the larger molds are of the jar-ramming, roll-over type. As fast as molds are made, they are set on horses, as shown in Fig. 1, from which they are transferred to the oven cars shown in Fig. 4. This illustration shows one of the horses carrying freshly made molds as well as the oven cars fully loaded. The cars operate on 24-inch gage tracks and portable track sections are provided for running the cars out into the molding room for loading and into the pouring bay for unloading. These portable sections which are about 7 feet long, can be readily moved about to meet the requirements of the work. When the flasks are loaded on the cars, the drags are stacked up on the bottom boards. Special separating plates, however, are provided for the cheeks and copes. These plates may be seen at the left in Fig. 4.

Drying Facilities Are Ample

The oven cars are of simple I-beam construction, with four wheels, and after they are unloaded in the pouring bay they are stacked, four or five in a pile, and returned to the molding room by means of the monorail trolley system. This arrangement makes it possible to take care of the work with a minimum number of cars and at the same time the cars are never handled by hand except when they are pushed in and out of the ovens.

As indicated in Fig. 6, six drying ovens have been provided and space has been left at the south end of the shop for the installation of another battery of the same size. Each oven is approximately 10 feet wide, 20 feet long and 8 feet in height. The entire battery is coal-fired from a conveniently located point in the basement.

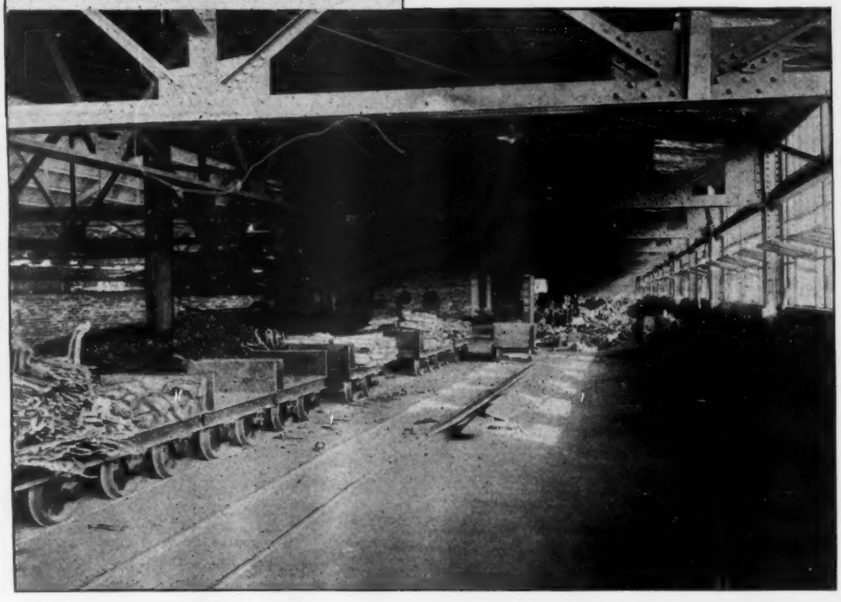


FIG. 8—THE CHARGING FLOOR IS UNUSUALLY LARGE AND WELL LIGHTED

The cheeks and copes are delivered directly from the drying ovens to the pouring floor where they are set out on low horses. The drags are transferred by the cranes to the core assembly department at the north end of the shop. At this point the cores

FIG. 9—AN AISLE IN THE CORE ROOM. FIG. 10—ANGLE-IRON CORE-OVEN RACKS ARE HANDLED BY ELEVATOR TRUCKS

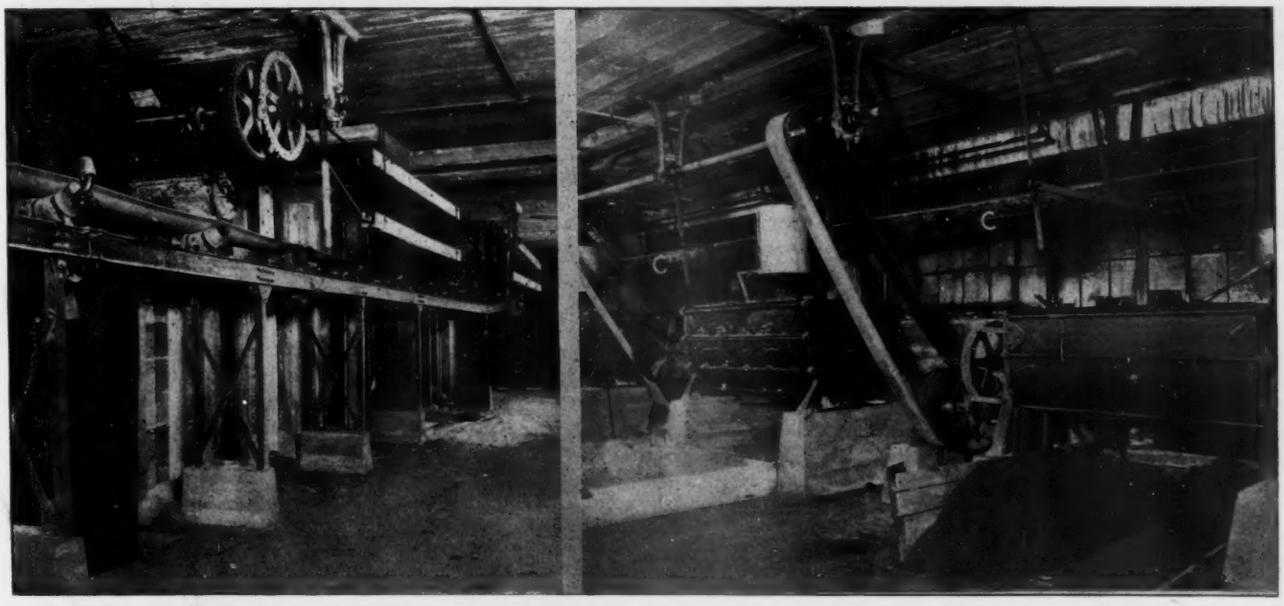


FIG. 11—CORE SAND ELEVATOR AND CONVEYOR. FIG. 12—CORE SAND MIXERS WITH DISTRIBUTING CONVEYOR, *C*

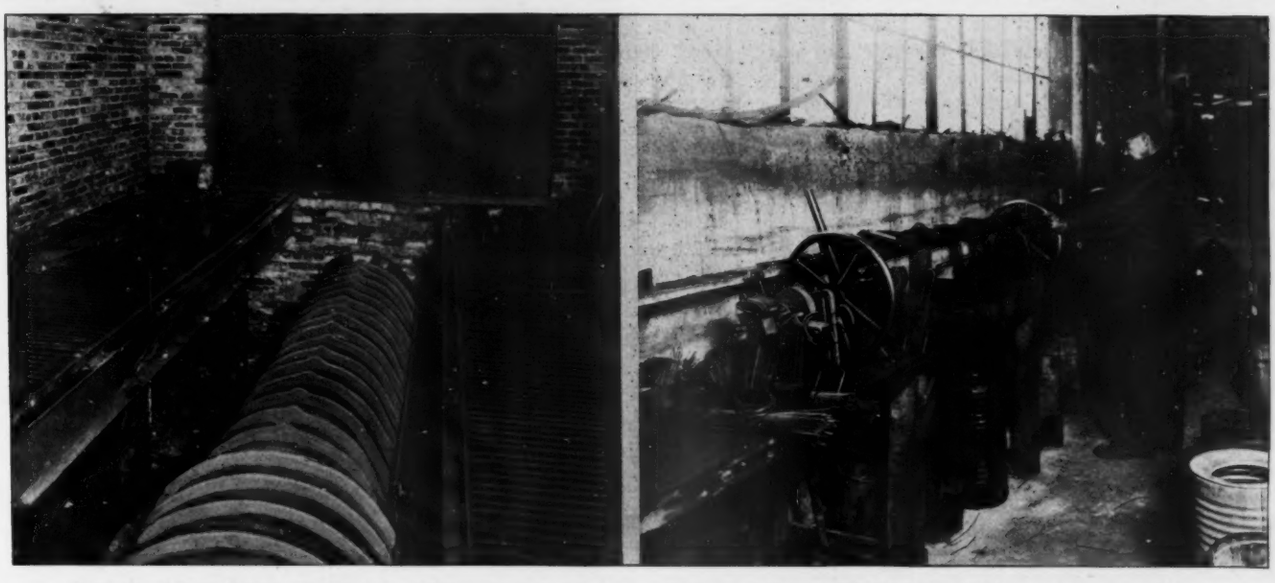


FIG. 13—CORE OVEN FIREBOX ROOFED WITH BUNGS. FIG. 14—MACHINES FOR BENDING CORE WIRES

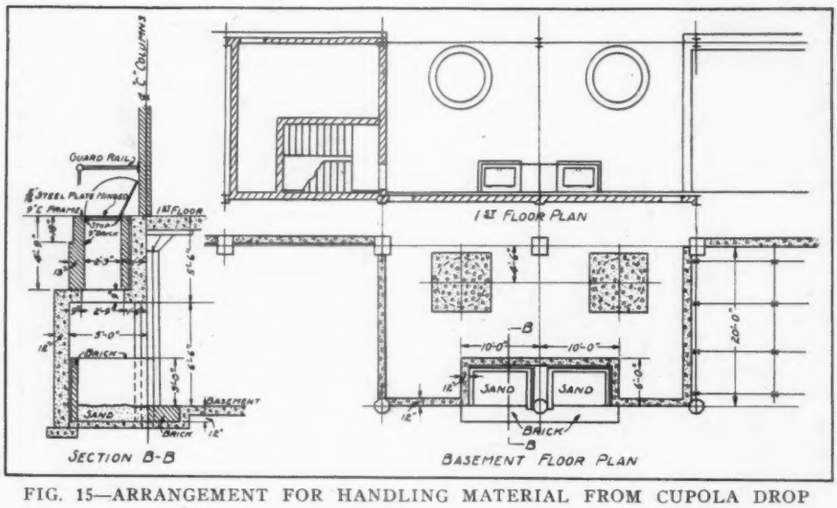


FIG. 15—ARRANGEMENT FOR HANDLING MATERIAL FROM CUPOLA DROP

are assembled by a gang of specially trained men. The arrangement of this department is shown in Fig. 5. The flasks are supported on horses during the assembling process. Each man is provided with a compressed air hose and nozzle for blowing out molds. The cores, of course, are assembled to jigs and gages in order to insure accurate work. As fast as the cores are set in the drags, the flasks are returned to the pouring floor where they are assembled with the cheeks and copes, and clamped for pouring, as shown in Fig. 7. This illustrates the floor about noon and indicates only a part of the day's work. A separate gang of men is employed for closing the molds and another gang does the pouring.

All of the work has been thoroughly subdivided and standardized with the result that the Lakey company is able to train a man for any given operation in approximately two weeks. This makes it unnecessary to employ highly skilled molders which are practically unobtainable at the present time. Also, with the class of men employed, there is less liability of labor trouble.

As previously explained, the flywheels, manifolds, pistons, etc., are molded and poured on the floors immediately adjacent to the cylinder pouring floor. This work is handled in a conventional manner, standard stripping-plate and rollover machines being employed. Dry-sand cores are used for molding pistons.

Two Whiting cupolas, 54 inches in diameter inside the lining, have been provided for melting the metal. These cupolas have a shell diameter of 72 inches and a melting capacity of 10 to 12 tons per hour. They are installed in the middle of the shop alongside the cylinder pouring bay, as indicated in Fig. 6, the cupolas being set with their centers 10 feet apart. The molten metal is handled entirely by the traveling cranes and monorail system. This makes it possible to deliver the metal to any part of the shop quickly and to handle it with a minimum of labor.

Special Receptacles for Cupola Drop

As previously stated, there is a basement under the bay in which the cupolas are situated. Advantage has been taken of this arrangement to provide for the disposal of the cupola drop. The arrangements for this purpose are clearly shown in Fig. 15. Behind each cupola is a trap door 2 feet wide and 3½ feet long. It consists of a steel plate hinged at the back. It opens into a brick-lined chute which discharges the material onto a sand hearth level with the basement floor. The sectional drawing at the left shows this arrangement. After the bottoms of the cupolas are dropped the material is raked into the trap doors through which it falls to the basement where it can be disposed of conveniently. The material from the drop is handled so quickly that there is no time for fumes or steam to accumulate in the cupola compartment.

At the Lakey plant an entire bay has been set aside for coremaking, this department covering an area of 13,000 square feet. The core benches are arranged along parallel aisles, as indicated in Fig. 9, with steel racks between the rows of benches for receiving the finished cores.

Fig. 10 shows one of the racks used while baking the cores. It consists of a framework of angle iron holding short lengths of pipe which form the shelves. This type of rack is not readily warped by the heat. It is inexpensive and if any of the pipes become damaged, they may be readily renewed. The rack is moved in and out of the oven by an elevating truck. The truck shown in Fig. 10 was furnished by the Barrett-Cravens Co., Chicago. A number of Cowan trucks also are used.

Unusually complete equipment has been provided for handling the core sand without the intervention of manual labor. The sand is obtained from the lakeshore nearby. The storage bins are in the basement under the core room at the north end of the building, paralleling the railroad tracks. The sand, therefore, may be conveniently discharged from the cars into the bins. A hopper is fitted into the floor of each bin with a screw conveyor underneath. These conveyors discharge into a bucket elevator *B*, Fig. 11, which delivers the sand onto a belt leading to the mixing apparatus. The elevator is provided with a distributor for feeding the sand onto the belt properly. Fig. 11 clearly shows the general arrangement of the apparatus. The belt conveyor discharges the sand into a large hexagonal, taper screen which removes the large pebbles and grades the sand.

The screened sand is discharged into a screw conveyor, *C*, Fig. 12. This conveyor, which runs the full length of the mixing room, is provided with suitable gates for discharging the sand directly into the machines. The arrangement of these gates is clearly shown in Fig. 12, which also indicates

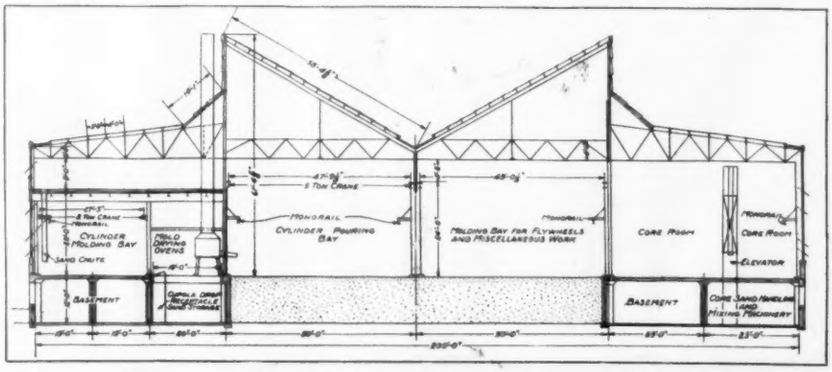


FIG. 16—TYPICAL CROSS-SECTION OF LAKEY FOUNDRY SHOWING ROOF CONSTRUCTION AND CRANEWAYS

the character of the sand-mixing equipment. Five mixers have been installed. Three were furnished by the Standard Sand & Machine Co., Cleveland; one by the Blystone Mfg. Co., Cambridge Springs, O., and one by the National Engineering Co., Chicago. The mixers are mounted on concrete piers to facilitate the discharge of the prepared sand. The latter is dropped into shallow floor bins from which it is transferred to wheelbarrows and buggies for removal to the core room above. The core sand handling plant was designed by H. W. Caldwell & Sons Co., Chicago, as were the conveyors, bucket elevators and screens.

A very unusual direct-acting elevator operated by compressed air is provided for hoisting the core sand from the mixing room in the basement to the coremakers' benches on the main floor. This elevator, designed by M. C. Young, master mechanic of the Lakey Foundry & Machine Co., is shown in Fig. 17. It consists of a framework with a suitable hoisting cage connected to an air cylinder 5 inches in diameter and 13 feet in length. In other words, the elevator is practically an enlarged, direct-acting pneumatic hoist. It handles from 300 to 500 pounds at one time and is unusually quick acting. It also was inexpensive. The hoist itself cost $95, the cage $57 and the entire installation less than $200.

The Lakey company makes no effort to reclaim its core sand since very cheap raw material of good quality is obtained from the shore of Lake Michigan nearby.

For baking the cores, two batteries of ovens have been provided, as shown in Fig. 6. One set of ovens, at the north end of the shop, are of the single end compartment type. Eight compartments, each about 12 feet deep and 7 feet wide, are provided. This oven is fired with coal from two fireboxes in the basement.

A new oven of the continuous, double-end type is now being installed at the south end of the core room. The interior of this oven which is 24 feet long and 16 feet wide, is shown in Fig. 13. This illustration indicates the novel flue and firebox construction. Instead of roofing over the firebox and main flue with brick arches of the usual type, cast iron bungs, similar to those used on air furnaces in malleable foundries, are employed, the principal difference being that in this case the bungs are nearly semicircular in form. The bungs are provided with a brick lining and are set in place in the usual manner. This construction makes it possible to make repairs in an hour or so and it is practically never necessary to shut down the oven for repairs to the firebox or main flue.

This oven also has a flat roof built of I-beams set on 24-inch centers with the intervening spaces filled with hollow tile. The Lakey company estimates that this type of roof costs half as much as a brick arch roof of ordinary construction. It also may be repaired easily by replacing individual tiles which become damaged. The core oven is 9 feet high and is provided with Kinnear rolling doors.

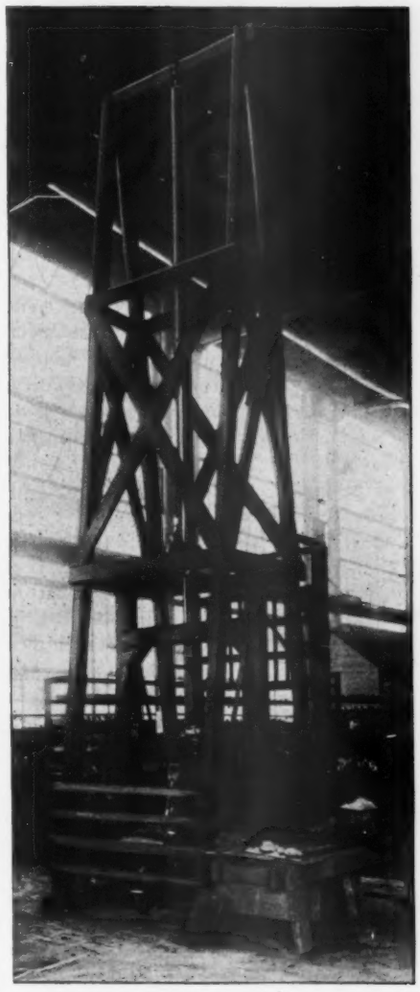


FIG. 17 — DIRECT-ACTING PNEUMATIC CORE SAND ELEVATOR

An unusually large number of wires are required for the cores for automobile and motor truck cylinders. Foundries specializing on this class of work, therefore, have to provide facilities for bending the wires to the proper shape and for reclaiming the used material. For this purpose, the Lakey company has installed three core wire bending machines of a unique type patented by J. A. La Course, Muskegon, Mich. These machines, together with the inventor, are shown in Fig. 14. Some of the work turned out also is illustrated. The machine consists essentially of a handwheel mounted on a shaft carrying a faceplate on each end. The faceplates are provided with jaws in which the wires are inserted. Various adjustable rests and standards also are provided over which the wires are bent. When the machine is properly set up, it will bend wires very rapidly and accurately. This department also is equipped with two wire-straightening machines of standard type.

The cleaning room at the south end of the shop has a floor area of 8500 square feet exclusive of the shipping department. An automatic room-type sand blast installation has been furnished by the Panghorn Corp., Hagerstown, Md. Suitable chipping benches, grinding stands, water-testing benches, etc., also are provided. The equipment in this department in general is standard and the methods present no unusual features.

The shop is provided with a heating plant consisting of two 100-horsepower return tubular boilers. These boilers are coal-fired. An additional boiler will be installed this summer. The steam from the boilers is passed through coils over which air is drawn by two large fans furnished by the American Blower Co., Detroit. From the fans, the warm fresh air is distributed through pipes to various parts of the shop.

The power for handling the machinery throughout the plant is purchased from the local central station. The current is led into a 6-panel switchboard from which it is distributed to the various motors, etc., throughout the shop. Four air compressor units are installed. Direct current for the cranes is supplied by a motor-generator set consisting of a 75-horsepower, 440-volt, 30-cycle motor belted to a 50-kilowatt, 250-volt, 200-ampere generator. The motor runs 850 and the generator 1150 revolutions per minute. This set was furnished by the General Electric Co., Schenectady, N. Y.

The pig iron, scrap, etc., used by the company, is stored in a yard adjoining the lake, north of the shop. This yard is separated from the plant by railroad tracks which run alongside the building. For conveying the material to the charging floor a bridge has been built across these tracks with an elevator at the outer end. The bridge is 65 feet long, with a clearance above the tracks of 34 feet. The elevator is of the customary platform type. A separate installation, including suitable receiving bins and a bucket elevator has been provided for transferring the coke directly from the cars to the charging floor without any re-handling.

Reasoning Applied to Foundry Work—Its Rewards

What the Power to Think Means to the Molder, Melter and Foundry Operator, With a Discussion of Inductive and Deductive Reasoning

By R R Clarke

AMONG the valuable assets of the human intellect is the reasoning faculty. This faculty is the third truth power of the mind. It is defined as that capacity for deriving, by a purely mental process, the unknown from the known, of comparing two truths already established and deducing a third truth hitherto undiscovered. The power itself is not to be confused with intuition or the reason which gives us facts quite independent of the reasoning process and on their own basis of reasonableness. As stated, two known truths are essential to the process. It is well-known that most metals expand and contract in the ratio of heat supplied and withdrawn. It is equally well-known that under identical conditions some metals increase and decrease in volume more than others. Among these is the element zinc which records one of the highest known coefficients of expansion. A foundryman making his first heavy casting from a high zinc alloy, such as tobin bronze, muntz metal, manganese bronze or yellow brass, may have no knowledge of the heavy shrinkage bound to occur, yet at the same time might readily derive this truth by reasoning power. That foundryman surely has observed that copper-tin, lead, low zinc alloys always have a tendency toward high shrinkage more than copper-tin-lead no-zinc alloys. Therefore, if he only goes to the trouble, he can get the facts together in this fashion: The element zinc expands and consequently shrinks greatly in casting. This alloy contains a high percentage of the element zinc, therefore it will shrink heavily in casting and something will have to be done to counteract this tendency.

But suppose this foundryman doesn't know what to do? Let him reason again. What is shrinkage or contraction? A volumetric return from an advanced to a normal temperature. Where is it greatest? Where temperature is greatest and bulk heaviest and the casting point highest. Why at the highest point? Because there the gate pressure is least and gravity is most advantageously active. Shrinkage must be met and overcome by a replenishing supply in keeping with the same conditions. What and where the casting locally loses that and there it must be fed. Every foundryman knows the function and capacity of the feed gate so the conclusion is to resort to it according to the demand. Suppose the casting is made of aluminum and of such bulk variation as to invite fracture by unequal contraction between light and heavy parts. Analysis again will clear up the situation. Why should the casting crack at the point mentioned? We know light bodies of metal will solidify in advance of heavier ones. We know, too, that in solidifying they recede from given molten positions. We know further that the invariable tendency of receding, solidifying metal is to draw from any available supply regardless of direction. The situation then frames itself to this: The light casting section solidifies first and draws from the still liquid supply in the heavy. Later, the heavy section solidifies and demands what is lost and then some. But by that time this light section has the metal beyond recall and in a fixed position. Therefore, the heavy bulk pulls away and leaves a fracture, an open breach.

Peculiarities of Aluminum

But give us the remedy. If they both cooled simultaneously or nearly so, then they could give and take mutually, adjusting their differences while in adjustable condition. Conclusively then, the thing to do is to make them cool simultaneously. But how? Surely the question is unnecessary. Foundry mortals are few who have never observed the difference between green or dry sand receptacles and the cast iron receptacle in influencing metal from liquid back to solid state. The man who first used an iron chill in a mold simply calculated on a rational basis that the iron chill would force a brief period of solidification in some part of the casting. While we have the element aluminum in hand we might consider its casting along another line. We know several things in common about this element. Most foundrymen are aware, for instance, that it has a low specific gravity and a fairly high fusing point. It should be simple of conclusion then that aluminum in the molten state will generously generate mold vapor pressure and will be easily disturbed by it. Observation must indicate that aluminum is one of the metals long delaying its congealation—slow to part with its liquidity, once attained. From these facts alone should it not be a simple matter to conclude that in working aluminum, sand should be worked on the dry side and the metal poured at a low rather than high temperature in order to minimize mold vapor pressure and delay its more serious activity until the metal in casting form has reached that stage of solidity where vapor pressure could do it no harm? The foregoing represent three common examples of foundry reasoning and illustrate how valuably safe certain phases of foundry practice might be made through the instrumentality of this third truth power. No man's job in a foundry, however important or insignificant it may be, can reach that stage where undiscovered truth and difficulty unsolved lie beyond the probabilities of experience, and no foundry problems are so hard-shelled that the reasoning power of the intellect cannot make some impression on them.

There are two methods of reasoning, the inductive and the deductive, meaning respectively leading up to and proceeding down from, or merely building up and tearing down. By the former method we get the general truths of experience, those all-embracing foils holding good in every case. There is nothing in this world more valuable to a foundryman than the general truths of his art. They constitute the fundamental principles of that art without which no man can successfully engage in it. As noted, these general truths are affairs built up from particular truths —things we daily note as continually occurring under the same conditions and without exception. When a particular truth holds good in every instance and phase of its varying application, it elevates to the status of a general truth unless some condition be logically conceived under which it might possibly fail.

The patternmaker's shrinkage rule is the outgrowth of a general truth.

Human experience is now satisfied that practically all metals obey expansive law. Men have derived this satisfaction from long time noting the effect of heat on the different metals individually. From the concurrence of effect in each particular instance, the same effect has come to be regarded as general. Consider the general truth that metal pressure on the cope of a mold varies with the number of square inches exposed. If we accept this truth in a practical way, then we will know absolutely that whether the casting be thin or thick, light or heavy, the metal lifting power is the same and will have to be brought under the same power of control.

Applying the Hydrostatic Principle

Likewise with the hydrostatic principle, that liquids derive pressure from height independent of volume. By this principle we know that a long, 1-inch diameter bar molded vertically will swell equally at the bottom with a 6-inch diameter bar. It may not sand-burn as severely, but it will swell the same under identical conditions. Consider further the fact that tin in a copper base alloy will reduce the melting point. When you come to make manganese bronze you use a prepared concentrate for a hardener, this concentrate containing the high degree fusing elements such as copper, iron, manganese, etc. Use of the concentrate in the regular mix, therefore, will presuppose a high temperature for melting, something you want to escape if possible. Your knowledge of the action of tin will influence you to include some of this metal in your concentrate, making a slight correction in the subsequent mixture for that lost by oxidation in the concentrate.

There are a great many general truths connected with foundry experience. Consider, for instance, the selection and purchase of metal ingots. By the general order of things the top side of any ingot ought to show a depressed rather than a raised surface. Under normal conditions, that is what invariably occurs when you pour your metal into a pig. Frequently metal ingots are marketed with a convex rather than a level or a concave top surface. Unsuspecting judgment might consider this an excellent brand of ingot, but is it? There are two sources to which the condition might be traced. As a matter of deception it may have been purposely done mechanically, or it may have followed as a consequence of absorbed gases, as the top surfaces of pouring gates will sometimes show. In the one case, we suspect something is wrong and in the other, a confessedly bad brand of metal ingot. One thing is certain, the situation conflicts with general truth, and something must be wrong.

In addition to the general truths we have the prevailing-order fact against which foundry judgment will always do well to check. One we might cite relates to the selection of men for foundry work. The fact is all but general that the habits and tendencies of men are fixed at the age of 40, that whatever they are at that age in their industrial proclivities they will remain the balance of their lives. Now at the age of 40 a man is supposed to be and no doubt is at his prime and yet representative experience will strongly indicate that a man at that age hunting a job under normal labor conditions merits little recognition in the majority of cases. If he is an efficient, valuable man, surely he has had opportunity to demonstrate it and is without good reason on the labor market. If he has been a troublesome man in previous instances, he will most likely continue so in succeeding cases. If he has been a rover, he has violated permanency, a fundamental principle of efficiency and bids fair to duplicate in after experience the same as in former. By the prevailing order of things his case will bear close investigation. Regardless of his skill or efficiency he is ultimately a losing proposition if he is making a change for any reason other than advancement. It was partly, if not chiefly, in recognition of this prevailing truth that one of the largest labor-employing corporations of the world first set its hiring age limit at 35 and then moved it forward to 40.

Method of Inquiry Formulated

In the investigation this corporation formulated a method of inquiry into the previous service of the applicant, covering a period of five years previous service. In more than one instance a man has been rejected with the explanatory remark: "You've had six jobs in the last year, we have nothing for you." The general truth, namely, prevailing order, was against him.

How to formulate general truths is well worth passing notice. Take the case of metal oxidation by atmospheric action. Practically all brass foundrymen, for some reason or other, have melted the different elements singly. All, doubtless, have noticed that in each particular instance, shortly after the melting point was attained, a scum collected on the liquid surface. When this scum was skimmed off it formed a metal dross. Happenings with every metal tried and giving good grounds for belief that it would continue to happen with those untried, the truth could be generally established, that regardless of what that point might be, fusing temperatures are dangerous oxidizing temperatures. In the light of such a truth, what foundryman can fail to understand and observe the logical order of introduction in combining his different metals?

Molding Principles

How are we to know that a certain truth in founding will cover all cases? By studying and comparing the individual instances as they arise and noting the absence of exception. Take molders, for instance, certain things they wouldn't do in any case, others they would and do in every case. Why? Because they have either been taught or observed that the same identical consequence follows every time. In this business of molding—and in practically every detail of casting creation—have you ever noticed that in substance everything connected with it embodies a general truth? Really there are no rules of molding, but instead, principles, binding laws obeying continuity to the letter and involving the same consequence though perhaps expressing it differently in different instances and with different metals and alloys. Independent of artistic accomplishment then, the good pattern designer, the good patternmaker, the good melter or the good molder is simply the one who from his daily experience has extracted a great mass of particular truths, compared them and reduced them to general facts which are the safe principles by which he is always governed. Among molders we have always noted three distinct classes: Those who know and use their knowledge; those knowing but not using and those not knowing. Practicing the same order prevails in every walk and by-path of life. The first is a wise man, the second a fool, the third an ignoramus.

Deduction means simply going from whole to parts and involves primarily a tearing apart of facts and conditions and getting to their fundamentals of composition. It allies closely with the analyzing power of the mind by which sane policies can be preestablished and difficulties studied and reduced. If you would know and understand the principles and mechanism of your foundry machines, your differentials, vibrators, sand-shakers, pneumatic hoists, molding machines, etc., study their parts and the relations of those parts to each other and you are on a straight line to analysis, the first principle of enlightened understanding. Likewise

with every foundry problem you are called upon to solve. There are two ways of solving it. You will eventually get it by jumping at it blindly and keeping at it long enough to hit upon the right method provided you don't repeat any one unproductive method. That's the way some foundries have got by their difficulties until they hit the final difficulty of keeping their heads above water. The other method is simply that of analysis, of studying the thing out carefully, doing things over in the mind before touching them with the hand. Because everything that happens in any foundry connection proves itself ultimately a reasonable event, something that might have been looked for. Take for instance super-heating copper. The hotter we get it the more fluid it becomes and the more expansive the more its molecules tend toward partition. Is it not reasonable to assume, therefore, that in such condition it is admirably fitted to absorb gases from which blow holes are developed?

Casting Difficulties Considered

Casting difficulties are among the most common things in the foundry world. A very little thing may often stand between the molder and his casting. These may include an unlooked for delay in delivering the metal to the mold after drawing it from the furnace; a single dump of wet sand, a loosened clamp, a mismated flask; a gate cut at the wrong place; a raising core, a filling vent, an ounce too much pressure on the rammer, a weak bottom board, a shaky and ill-barred cope, insufficient weight on the sand, a shade too hot or too cold in pouring—a thousand and one things if we were to tabulate them. It's a matter of common foundry experience that some molders can be trusted to deliver a good casting from a pattern they never saw or worked before. Such molders we call good molders. It is equally common that other molders always slip up some way and get a bad job. These we call poor molders. The difference is not necessarily one of skill, but rather of brains at work. The one reasons out the manifold difficulties involved, while the other almost invariably lets one or more escape him. Many plates have been mounted for machine molding only to demonstrate their worthlessness, to expose a one-sided conflict between principle and practice in pattern arrangement, construction, in coring, gating, tamping, lifting, or some other of the many incidentals involved.

We remember once visiting a foundry doing a large amount of work on pneumatic squeezer machines by using snap flasks. We noticed one of the machine molders make a dozen or more molds only to shake them out and curse. Out of curiosity we walked over near him. The plate contained some 15 deep plug patterns with a hexagon top. In lifting the plate the middle patterns tore the mold up shamefully. The trouble was easy of location. The patterns were placed very close to each other. The drag had to be squeezed less than the cope. The pattern field was some 12 x 14 inches and the plate was 1/16-inch boiler steel. By soft-squeezing the drag and hard-squeezing the cope, the plate went centrally down, under the greater pressure forcing that sand density in the drag that the operator was trying to avoid, throwing his patterns out of perpendicular in the bargain. Surely nobody *was home* when that plate was selected and those patterns mounted.

By comparison we can derive a clear insight into the nature and formulation of alloys. Why is the 88-10-2 mixture hard and of great strength, whereas the 85 and three fives, made of identical brands, is much softer and less rigid? Would the addition of 5 pounds of lead and 3 pounds of zinc at the expense of copper make 88-10-2 in the same physical property class as 85 and three fives? You feel sure that it wouldn't. You must conclude, therefore, that hardness and strength in 88-10-2 are derived chiefly from the advanced tin content and that is a fact you can safely rely upon in formulating any alloy to which tin is admitted. Again, suppose in 85 and three fives you dropped lead and added that much more tin, what result would follow? A slight change in color, a decided advance in hardness and an additional toughness that would show up perceptibly in machining. Analytically, how do we account for the change? Two quantities have been distributed, tin and lead. The tin would make it considerably harder, but wouldn't account for all of it. It could have nothing to do with an increased toughness as affecting machining qualities. Beside these two changes, the alloy would be found reduced in density. Could tin account for that? Hardly. Now we have the third truth cornered. It is that lead must be the responsible instrumentality, and that when we want an alloy mechanically densified, of reduced toughness in machining, we will have to consider the element lead. But suppose you excluded zinc from any one of these alloys at the gain of any other element, what would the result be? First, the color would change and the grain of the alloy would be perceptibly altered. Furthermore, the molten metal would appear more sluggish and less lively and would be less clean. In physical property it would lose slightly of toughness. This is achieved through the elimination of zinc and the conclusion is easy of deriving as to the primary function of zinc in the copper base alloy.

The Use of Zinc

You may some day want an alloy that will be tough, malleable, golden in color and clean. If you put your reasoning power to work you will not overlook the element zinc in formulating that alloy. But how is the average foundryman to know that these different elements are responsible for these different effects? Isn't the average foundryman working them practically every day of his life? How does he know that salt will take the flat taste out of his soup? In your foundry you are using immense quantities of scrap, more perhaps than ever before. Perhaps at first you subjected the various forms of scrap to the same furnace conditions as you accorded your metal ingot. If you did you bumped into molten metal abnormally drossy and dirty castings. Could you have looked for that condition? What is the ratio of volume to surface in a metal ingot? Very high. What in metal wire, sheeting, etc.? Very low. To get the same melt from the latter as the former then you exposed a vast sum total of surface which simply meant that you gave metal oxidation that much greater advantage. Now you needed neither the same time nor temperature and you should have reasoned that way because you know if you know anything about melting metal, that resistance to fusion in any metal or alloy varies with ratio of surface to volume. Perhaps, too, you never opened your furnace door to skim off the oxide dross. Now the contention is that all these things are so naturally and reasonably sure to happen that a foundryman's reasoning power ought to anticipate and forestall them.

Recent years have brought wonderful changes in founding, its practice, its materials, its equipment, etc. Did you ever think that of all these added benefits not one ever got into the foundry without first going through some one's head. And this head-going was simply a reasoning movement. You remember the days when phosphorus was unknown, charcoal was never seen, silicon formed no

part of any alloy, manganese not on the market, aluminum worked all by itself and the ferrous elements barred from the family of alloys.

They are with us now and they didn't come by chance. Some men knew something and reasoned to something else. They knew the average alloy in molten state to be oxide-polluted. They knew phosphorus, silicon, manganese, charcoal and other different elements to possess a strong affinity for oxygen. So they reasoned that these elements in an alloy would combine with the oxygen of the oxide, pass it off and leave a clean metal behind. You remember the day perhaps you despaired of ever getting a solid casting from pure copper. Your lost hope was a gas blubber—not one, but hundreds in your casting. You are past that difficulty now because some one reasoned that silicon would take care of the situation.

Likewise with your modern foundry equipment. From the old to the new, reasoning power has led the way from the hand brush to the tumbling barrel onward to the sand blast; from the hand hammer, chisel and file to the band saw, sprue cutter, pneumatic chisel and acetylene flame; from set gate to the snap flask to the hand-ramming machine onward to the power, from all things foundry-old, slow and cumbersome, the foundry world has passed through the gates of thought, forward to the new and better. Thought is the basis of progress.

What have you adopted in your foundry to meet your local conditions, which is expressive of your own creative power and that, so far as you know, no other foundry has? Surely you have need of something, and what you have, whether much or little, is a criterion to your reasoning capacity along your chosen line in founding.

Foundry Reasoning Power

We have often said that all foundry working mortals differ primarily in the head. They are relatively good, bad or indifferent according to their brain power and the use made of it. Times without number we have seen a molder stop for want of power to proceed further only to see another jump the situation and reason his way through it. And the things they have reasoned to are wonderful examples of intelligence ploughing through a temporary difficulty. One case we might mention. A pattern was brought into the foundry under stress of great casting hurry and importance. It called for a three-part flask by virtue of a loose and underside complicated section. We hadn't a three-part flask about the place that would answer the purpose, but we had a deep-drag of a two-part flask of the proper dimension. It looked as though the job would be held up until the next day, when a molder came forward with the conviction that he could make it in the two-part flask. His plans were to use a smaller flask inside the larger flask to take care of the loose and complicated section to have a mold within a mold and to run the drag of the two-part flask up to that point of parting where the loose joined the main section; to make this parting, then set the smeller flask and work its position carefully and accurately; to ram it up, lift it off, draw the loose pattern section, set the flask carefully back, protect its bottom sand with a good bottom board, and go ahead as usual. That molder got the job and the casting was delivered in the early evening of that same day. These reasoning fellows, these thinking fellows, they are the most valuable men in the world to have around. They can save you much trouble in a day's time.

Some men have great reasoning power, others less of it, still others practically none. Primarily, the difference is, some have reasoned more than others have time and patience to go analytically into the details of experience and knowledge with the view of cleaning up the fundamentals and deriving the related facts. They have met the conditions, paid the price and the reward cannot be denied them. Their reasoning faculty is larger because they have exercised it the more and fundamentally, exercise is the law of all mental growth.

Allied Metals Congress in Milwaukee

SIMULTANEOUS meetings of four great technical and business associations allied with the country's iron, steel and brass industries will be held in Milwaukee during the week of Oct. 7. Concurrent therewith will be conducted the annual exhibition of foundry equipment and supplies, machine tools and accessories in the Milwaukee Auditorium, under the auspices of the American Foundrymen's association. These four gatherings, with the added exhibition feature will constitute the greatest congress of the metal trades ever held.

It will bring together the members of the American Foundrymen's association, who represent the gray iron, steel and malleable casting interests of the United States and Canada; the Metals division of the American Institute of Mining Engineers, formerly the American Institute of Metals, representing the nonferrous metal casting and brass and copper rolling mill industries; the Iron and Steel section of the American Institute of Mining Engineers, representing the blast furnace, steel works and rolling mills and the American Malleable Castings association, representing the malleable casting industry.

The men who will attend this congress and who are directly affiliated with every branch of the metal-working trades, are probably in closer contact with activities for the conduct and successful prosecution of the war than any similar body of men of any other industry. The subject of many of the papers, addresses and discussions will bear directly on operations to facilitate production and to speed-up the manufacture of ordnance, munitions, ship castings, etc. Never before has such an alliance of simultaneous meetings of such great technical organizations been held.

It has been suggested that the congress be opened with a joint meeting of the members of the four societies and that speakers of national fame be invited to deliver addresses. They would sound the patriotic note that would underlie the deliberations of the four organizations, which would be continued throughout the week. The exhibition of all kinds of metal-working equipment would incorporate the most recent improvements in machinery to increase production and to supplant the country's constantly declining man-power. In addition, it is planned to have an exhibit of war materials representing the output of the metal trades. Such a display would be of tremendous educational value to all manufacturers, the majority of whom have little knowledge of the application of the part or parts which they are manufacturing to the assembled war machine, engine, motor, etc. Although this exhibition is still four months deferred, many manufacturers already have applied for space and several have requested reservations for double the floor area which they occupied at Boston. C. E. Hoyt, manager of the exhibition department is located at 1951 West Madison, Chicago.

By an overwhelming majority, the members of the American Institute

of Metals decided to affiliate with the American Institute of Mining Engineers and hereafter will be known as the Metals division of this organization. As previously stated in these columns, two meetings of this division will be held annually. The fall meeting will be at the same time and place as the annual convention of the American Foundrymen's association and will be devoted to the consideration of the problems of brass foundrymen, while the gathering in February, in New York, will be limited to the discussion of the metallurgy of metals and brass and copper rolling mill topics. The Metals division will continue to retain its own officers and will maintain its former identity, with the exception of its affiliation with the parent body as above mentioned.

PROBLEMS OF THE BRASS FOUNDER

What To Do and How To Do It

Overcoming Porosity in Bronze Bushings

We have experienced considerable difficulty in overcoming porosity in bronze bushings ranging in weight from 1100 to 3500 pounds. The holes are not apparent on the surface of the castings, but become visible when the bushings are machined. We are of the opinion that this porous condition may be caused by trapping air in the mold as the result of slow pouring. Kindly let us know whether it is more advisable to pour these molds vertically, using finger gates connected to a runner all around the top, thereby dropping the metal directly into the mold, or to make a split pattern, molding horizontally and flowing-off some of the surplus metal.

Large bushings are cast successfully by both the methods outlined and considerable discussion might be indulged in regarding the most satisfactory of these. If the bushings are long, the vertical method of casting more readily insures uniform wall thickness, while with horizontal casting, special rigging is essential to provide a core bar of sufficient strength to prevent it from being sprung by the hydrostatic pressure of the molten metal. The core also must be provided with metal prints seated on metal in the molds. By careful coremaking and by properly securing the core, gray iron columns have been successfully cast horizontally with green sand cores. Some of these castings have been 2 feet in diameter and 25 feet long.

In making bronze bushings a loam core, swept on a barrel for horizontal molds, gives good results. In this instance, if the patterns are made for vertical pouring, it would be advisable to try the method outlined and filling the mold rapidly. Melt under a cover of charcoal and throw charcoal on the metal in the ladles as it is being transferred to a large ladle and leave charcoal on the metal in the latter until just before pouring. This will aid in preventing the oxidation of the metal which is one of the causes of porosity. The addition of 0.25 per cent phosphor-copper also is recommended.

A Uniform Color for Plumbers' Brass Goods

We have experienced difficulty in obtaining a uniform color on plumbers' brass goods. We would like to obtain a carrot color on our castings. We have used the following alloy: Copper, 85 per cent; tin, 7 per cent; zinc, 5 per cent and lead, 3 per cent. The molds are faced with flour which is applied twice and blown off. We have never been able to approximate the time that should elapse after the castings are poured and before they are removed from the molds and dipped in water.

While the mixture is a good one, it is somewhat too high in zinc for the percentage of tin used to produce the best color effects and the alloy would be improved if the zinc content were lowered and replaced with copper. The following mixture might be substituted: Copper, 88.5 per cent; tin, 5.5 per cent; zinc, 3.5 per cent and lead, 2.5 per cent. Your method of applying flour to the molds as a rule produces excellent results. However, in view of the scarcity of this commodity, it might be advisable to dust a parting compound on the molds in place of flour. Some brass foundrymen figure that a casting should remain in the mold after pouring for periods computed on the basis of three minutes per pound of casting. The water should be clean and cool to produce the best effect. The condition of the sand is an important factor and it should be renewed frequently with new sand. If rosin is used as a binder in the core mixtures, care should be exercised to prevent the core sand from being mixed with the molding sand, as otherwise it will be impossible to obtain a satisfactory color on the castings which you will produce.

Bronze Colored Solder With a Low Melting Point

We would like to obtain a formula for a solder that will resemble red brass of the following mixture: Copper, 85 per cent; tin, 5 per cent; lead, 5 per cent, and zinc, 5 per cent. The solder should have a low melting point. We desire to employ this solder in closing small holes on soft, machined surfaces of large castings that we make.

It is impossible to produce a solder of bronze color that will have a low melting point. The metals that melt at low temperature are all white and cannot be alloyed with any element that will affect this color. The only method by which the holes in the castings may be filled is by brazing with a solder containing 50 per cent zinc and 50 per cent copper, but the color will not match that of the machined castings. If you are of the opinion that arsenic in the zinc is the cause of the porosity of the castings and if analysis develops that the zinc contains an high arsenic content, which is improbable, it is only necessary to change the brand of zinc you are using to get away from the difficulty. If the porosity always is found to develop on the same surfaces of the castings and is a localized defect, it indicates that something is wrong with the treatment of the mold at this point. If the mold is washed with plumbago and skin-dried, make a change in the plumbago wash, mixing the plumbago with a weak solution of glue in water before applying. If your difficulty is not solved by changing the plumbago wash, mix sharp sand with the molding sand for use where the porosity occurs. Also, locate a riser above this point which will permit the metal to be flowed off. The addition of 0.25 per cent of manganese copper also is advisable. This should be added just before removing the metal from the furnace to secure the best possible results.

Mixtures for Metallic Packing

We would like to have a mixture for metallic packing suitable for superheater locomotives. We have experienced considerable difficulty in making a packing that will withstand the high temperature of the steam, as it either melts or breaks on exposure to this excessive heat.

The following alloys are used extensively for metallic packing:

Tin, 33 per cent; lead, 64 per cent; copper, 2.50 per cent and antimony, 0.5 per cent.

Tin, 42 per cent; antimony, 17 per cent; lead, 38 per cent, and copper, 3 per cent.

Tin, 64 per cent; lead, 25 per cent; antimony, 7.5 per cent and copper, 3.5 per cent.

All of these metallic packings have a low melting point and, therefore, it is probable that Parsons white brass would be satisfactory for your work. Typical formulas follow:

Tin, 65 per cent; zinc, 32 per cent and copper, 3 per cent.

Tin, 60 per cent; zinc, 38 per cent and antimony, 2 per cent.

If the latter alloys melt readily, the only one that can be used consists of 50 per cent copper and 50 per cent lead. This mixture, however, must be melted in a brass furnace and the castings poured in sand, after which they are machined.

Casting Pipes in Copper Castings

We are experiencing considerable difficulty in casting pipes in copper castings for electric generators. The pipes vary from ¾ to 1 inch in diameter and extend through the casting. Blow holes and spongy spots develop in the vicinity of the pipes. Is it practicable to use phosphor-copper in mixtures in which zinc also is employed?

Your trouble undoubtedly is due to neglect in removing oxide and scale from the surface of the pipes before they are placed in the mold and still better results could be obtained if the pipes were heated. A sand-blast is recommended for cleaning the pipes and if this is not available, they can be ground on an emery wheel and sandpapered. It is essential that the pipes be cleaned of all scale, as otherwise gas will be generated when in contact with the molten bronze. Before the pipes are placed in the mold they should be heated, but not to a temperature to cause oxidation. When the metal is poured it should be flowed out of the mold into risers so placed that the first metal coming into contact with the pipe at the point where the most blow is liable to occur, can be flowed off into the risers and be replaced with fresh metal that usually will lie quiet. If the pipes cannot be placed in the molds in the heated condition, provision should be made to heat them with gas or torches after they are in place. Heating prevents the condensation of moisture on the surface of the pipes while they are in the mold.

Phosphorus generally is employed in mixtures containing zinc, particularly in gun metals, as it greatly improves the physical properties of these alloys. Phosphorus also is used occasionally in yellow brass, but the total content should be low.

Preventing Honeycombing and Porosity

Castings made from an alloy containing from 5 to 10 per cent lead are honeycombed and porous. The metal is melted in an open-flame furnace. We realize that some deoxidizing agent should be used, but we desire to eliminate phosphorus.

Careful melting practice will enable you to get along without phosphorus in most brass mixtures, but every precaution should be exercised to protect the metal from oxidation. The porosity which you are experiencing may be due to high sulphur in the oil, the oxidation of the metal resulting in the formation of sulphur dioxide. If this is the case, the addition of phosphorus would not insure sound castings. Phosphorus is the best deoxidizing agent thus far introduced in foundry practice, but it seems necessary in this instance to get along without it. Therefore, if you use glass as a cover for the metal, it might prove helpful. Powdered glass should be employed so that it may be mixed with charcoal and sodium hydroxide or common lye. A mixture of plaster of paris and common salt also is used frequently as a flux to protect metal.

"High Speed" Bronze for Bearings

What is the composition of a high speed bronze for bearings? We receive many inquiries for core bars of different sizes made of this alloy, and if we knew the mixture we could cast them in our foundry.

The exact mixture of bronze that is being used for this purpose could be ascertained by having an analysis made. The term "high speed" is not indicative of any property of the bronze nor is there a standardized alloy designated by this term. The following mixture, however, will serve the purpose: Copper, 87 per cent; tin, 11 per cent, and zinc, 2 per cent.

Making a Special Bronze Mixture

We have received an order for special bronze castings to be made of the following mixture: Copper, 88 per cent; tin, 10 per cent, and antimony, 2 per cent. The castings weigh about 18 or 20 pounds each and are of plate form, about ⅜ to ½ inch thick. We operate an open-flame, artificial gas furnace. Will you kindly give the best method of melting this mixture?

Melt the copper under a flux that will form a liquid slag, thus protecting it from oxidation. If charcoal can be kept on the metal, it also should be used, but if not, anthracite coal dust or fine pea coal may be employed. If these are not available, coke dust can be substituted. Ordinary bottle glass, with the addition of a small amount of borax, makes a good flux. When the copper is melted, add a small mount of phosphor copper, about 0.25 per cent or less, then follow with the tin and the antimony. The addition of the latter element will greatly decrease the tensile strength and elongation of the alloy. It will reduce what otherwise would be an excellent alloy to one that is no better than a common, leaded red brass. If the antimony can be omitted, it would be advisable to do so.

White Metal Pattern Alloy

We would like a formula for white metal patterns.

One of the best alloys for white metal patterns consists of zinc, 50 per cent and tin, 50 per cent. The shrinkage of this mixture is very low and, therefore, it is used extensively for pattern work. A cheaper alloy consists of lead, 80 per cent; antimony, 15 per cent and tin, 5 per cent.

The Advantages of Phosphor-Copper

Why is phosphor-copper recommended so frequently for use in bearing metals in place of phosphor-tin? How many pounds of phosphorus should be added to copper or tin to produce phosphorized metals? Do you recommend melting zinc and tin together when one part of zinc and two parts of tin are required in an alloy to prevent the loss of zinc when added to the molten copper?

Phosphor-copper is recommended because it may be added to the mixture more conveniently than in any other form and the amount of copper added to the alloy is only trifling. Also, it contains more phosphorus than phosphor tin. In making phosphor-copper it is necessary to add about double the amount of phosphor used which the alloy should contain, to allow for loss by volatilization. It is good practice to melt the white metals together first.

Die-Casting of Aluminum Bronze Investigated

Results Obtained by the Addition of Iron and Manganese to Copper—
Aluminum Alloys Are Discussed and Material for the Dies is Described

By H Rix and H Whitaker

DIE-CASTING may be defined as "finished castings, made by pouring molten metal, flowing by gravity or under other external pressure, into a metallic mold". Some of the advantages of die-casting follow:

Accuracy and uniformity of the castings, which can be made to specification 0.005 per inch, or even less for small parts.

Machining costs are either eliminated altogether or are greatly reduced.

The process is continuous, and the output generally is much greater than with sand-casting. Articles impossible to sand-cast may be successfully die-cast.

Although the process has been in operation for over 20 years, it is only during the last 10 years that it has assumed importance of a separate industry, and this is largely due to the development of the automobile and airplane The alloys employed may be divided into five classes, according to whether the principal constituent is zinc, tin, lead, aluminum or copper. Owing to their low melting points alloys of the first three classes were initially employed, but the castings lacked strength and rigidity. An average zinc base alloy has a tensile strength of about 8 tons per square inch, with practically no ductility, but these alloys are liable to corrosion and distortion. The tin and lead base alloys include a large number of the babbitt or bearing metal type, and many bearings are now being die-cast. The low specific gravity, cheapness and strength, when alloyed, of aluminum, have been the principal factors in its development as a die-casting metal. Its chief drawbacks are:

Its high melting point, compared with lead, tin and zinc.

Its tendency to attack iron when molten.

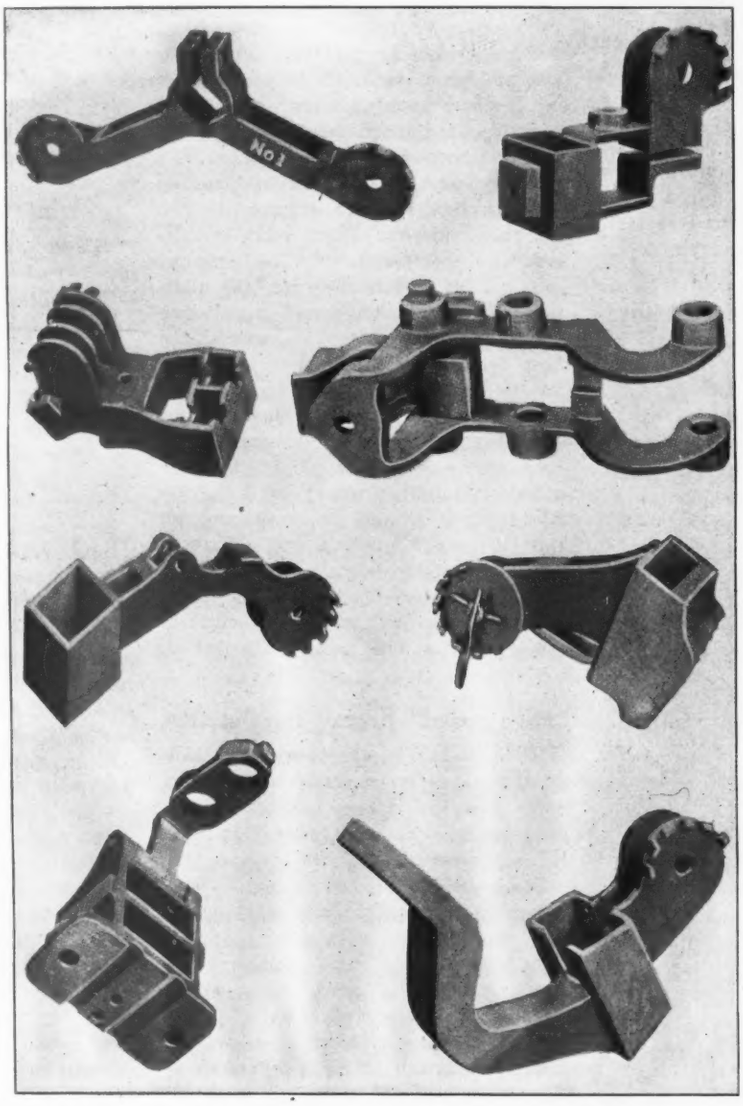
Its high shrinkage.

Its weakness at high temperatures.

On account of its tendency to attack iron the plunger type of machine has been largely superseded by one employing air-pressure, or by utilizing the pressure of the riser or gate. A die using zinc-base alloys lasts almost indefinitely, but when using aluminum alloys, cracks begin to show after 2000 or 3000 castings have been made. The high shrinkage of aluminum has been reduced by alloying, and need not exceed about 1.4 per cent.

The weakness of the alloys at high temperatures is responsible for the formation of cracks which develop while the metal is solidifying in the mold. Thus the strength of the copper-aluminum alloy containing 12 per cent copper drops from 8 to 10 tons per square inch at 0 degrees Cent. to 3 to 5 tons at 350 degrees Cent. Notwithstanding these drawbacks, aluminum alloys of variable composition are being successfully die-cast on a large scale. The next step in the process was to surmount the difficulties connected with copper-base alloys, which have a much higher melting point. The literature on the subject as yet is scant, but most of the workers in the field express the opinion that brass or bronze die-casting is almost a commercial impossibility. The results of the work of various investigators lead to the following conclusions:

1.—The chief difficulty involving the use of yellow metal is the high temperature at which it is melted, namely, 900 to 1000 degrees Cent. This has several effects. The zinc in the brass attacks the steel die which rapidly deteriorates, so that no more than 1000 castings can be obtained. The high shrinkage of brass sets up strains within the die which further impair its accuracy. Since the die cost is the prime factor in die-casting, this is a serious prob-



EXAMPLES OF ALUMINUM BRONZE DIE-CASTINGS MADE IN IRON DIES

Presented at the recent meeting of the Institute of Metals held at London, England.

lem. For the same reason it is impracticable to use an iron container for the molten metal, as the alloy would rapidly become contaminated thereby; hence air pressure cannot be employed to force the metal into the die. This means pouring from crucibles, with consequent slowing down of production, if only one die can be used. Another consequence of the high temperature and slow pouring is the large amount of dross which is formed. Also, ordinary brasses are not sufficiently strong at high temperatures to withstand the shrinkage strains.

2.—It is difficult to produce brass die-castings which are consistently free from blow-holes or shrink-holes. The former are caused by air being entrapped in the mold, and they cannot be overcome by simply increasing the pressure in the mold or by carrying out the process *in vacuo*. By a careful study of the venting and gating of each part, however, this unsoundness may be practically eliminated.

3.—Brass and bronze die-castings are only a commercial success if the parts cannot be completely produced by automatic machinery, or when they obviate numerous difficult machining operations, involving different settings of tools. To compete with the machined products the die-castings must be rapidly made, must be accurate to within ±0.002 per inch, and must have a smooth, polished surface. Recent developments in foundry and machine shop practice have made it possible for many parts to be now more cheaply sand-cast, and yellow metal die-casting is "practically restricted to pieces of fairly simple shape, weighing between ½ ounce and 3 pounds".

Experiences of the Authors

The experiences of the authors in this connection have been chiefly in the use of brass (60 : 40) containing about 2 per cent aluminum; manganese brass and aluminum bronze containing iron. In the first case, the aluminum is added to give fluidity to the metal and better definition to the castings. In the second case manganese brass of usual composition is used, containing less than 1 per cent manganese, with a little iron and aluminum. The chief objection to these metals is that the surface of the die becomes rapidly covered with a coating of zinc oxide which must be brushed off after every cast or the definition is spoiled. Various methods have been tried to overcome this difficulty, but so far without complete success.

Our best results, however, have been obtained with aluminum bronze containing iron. The first alloys experimented with were of copper-aluminum containing about 10 per cent aluminum, the balance being copper. The results were disappointing, as the metal did not lie quietly on the surface of the die and the definition of the edges was poor. After repeated trials it was decided to add a little iron, when much better results were obtained.

In their masterly research on the copper-aluminum alloys Carpenter and Edwards brought the investigation to a point "where the way is clear for investigating the influence of a third metal". Rosenhain and Lantsberry discuss the reasons which led to the selection of manganese as the third metal, and it is rather singular that iron does not seem to have been considered as even a possibility. Vickers alludes to the prejudice which appears to exist in the minds of most foundrymen against iron in copper alloys, probably due to its harmful effect when present in brass in any quantity. He also states that the use of iron in aluminum bronze is no new thing, but has been common in Germany and the United States for some years. While claiming that it improves the metal for sand-casting, he questions its use in die-casting, for the following reasons:

1.—In sand-casting it is necessary to add iron in order to prevent the excessive crystal growth which is "such a drawback to the 10 per cent aluminum bronze".

In die-castings this is not necessary, as the chilling effect of the die is sufficient to keep down this growth.

That the iron has this effect is shown by Corse and Comstock. Combined probably with aluminum and copper the iron is the first constituent to separate out in the form of small, black crystallites, which form nuclei round which the a-solution crystallizes, thus reducing the grain size.

2.—Iron accentuates the shrinkage of the bronze, consequently increasing the tendency to form the pear-shaped cavities commonly found in aluminum bronze die-castings.

The authors do not agree with the above conclusion limiting the usefulness of copper-aluminum-iron alloys to sand-castings, having produced many thousand die-castings in these alloys.

Causes of Cavities

The cavities referred to are certainly a difficulty to be overcome. They are either shrink-holes, caused by the large contraction of the metal, or blow-holes caused by air being entrapped in the die by the molten metal, and they may be detected in a casting by finding its specific gravity. Their direction is often radial, and they may be colored black inside. In either case, they may be practically eliminated by a careful study of gating, venting, etc.

Tetmajer has worked with aluminum bronze containing iron and silicon, but what appears to be the most complete account of the copper-aluminum-iron alloys is by Corse and Comstock.

They have studied the properties of the possible combinations containing 1 to 4 per cent iron and 7 to 10 per cent aluminum inclusive. Their conclusions are that "for the same aluminum content there is always an increase of proportional limit, yield point and ultimate tensile strength with increasing iron content, and in general a rather less substantial decrease in elongation and reduction of area. In the same way, with constant iron content, the proportional limit, yield point and ultimate tensile strength increase with increasing aluminum, while the elongation and reduction of area decrease. Also, that for a given strength, better ductility can be obtained with a lower aluminum and high iron alloy, than with higher aluminum and low iron."

Conclusions of the Authors

It is difficult, of course, to compare the results of different workers on similar alloys, owing to lack of uniformity in methods of preparation and testing, but a comparison of the results contained in the Eighth and Ninth Reports to the Alloys Research committee, and those obtained by Corse and Comstock, leads to the following conclusions:

1.—Iron and manganese, when added respectively to copper-aluminum alloys containing 7 to 10 per cent aluminum, have a similar effect, that is, the yield point and ultimate tensile strength are raised at the expense of the ductility.

2.—In the case of sand-cast bars, the addition of iron appears to give better all-round mechanical properties than the addition of an equal amount of manganese. The data are not available for a complete comparison of the chill cast bars, but some promising results have been obtained by the authors with alloys containing 7 to 10 per cent aluminum and 1 to 4 per cent iron. The authors are producing die-castings commercially in one of these alloys, and the following are the average results recently obtained from 24 test bars, cast in a 1-inch chill and cooled in air: Diameter of test section, 0.564 inch; yield point, 14.7 tons per square inch; ultimate tensile strength, 35.5 tons per square inch; elongation in 2 inches, 24 per cent, and reduction of area, 21.8 per cent.

It should be pointed out that each bar represents a batch of castings, produced consecutively during a period of several months, under ordinary foundry conditions.

These results compare favorably with those for the chill cast bars containing 7 to 10 per cent aluminum given in the Eighth Report, and for those containing 8 to 10 per cent aluminum and 1 to 5 per cent manganese given in the Ninth Report. In several cases the latter alloys give better results, but whether they may be die-cast or not is open to question.

The mechanical properties of the

copper-aluminum-iron alloys may be profoundly modified by heat treatment, and this probably accounts for the variable results obtained with the same metal under ordinary casting conditions. Consequently, accurate pyrometric control of the die-casting process is advisable, if consistent results are required. The temperature of the molten metal should be known, and that of the die itself, also the rate of cooling of the hot casting should be standardized. Much different mechanical properties would result if instead of quenching the casting red hot from the chill, in cold water, it were allowed to cool slowly in air.

An advantage of the alloy used by the authors is that it is sufficiently fluid to fill the die and give satisfactory castings through a wide range of temperature.

Material for Dies

The authors have experimented with several materials, ferrous and nonferrous, for die-making, but have had the best results with a close-grained iron, as hard as is consistent with good machining properties. The block of iron from which the die is made is itself chill cast, to give these qualities. Sometimes the dies have been cast almost to shape before machining, but the results have not been very satisfactory.

It need not be pointed out that a die, when once made, is only suitable for one particular alloy. Each alloy has its own requirements regarding gating, venting and shrinkage, and the particular problems of each new part render it difficult to make a correctly designed die at the first attempt. In an iron die as described, there can be made from 5000 to 7000 castings similar to the butterfly type of carbon brush-holder marked No. 1 in the accompanying illustration before it shows signs of deterioration. No facing or special treatment of the die surface is necessary, nor is the die cooled every few minutes; but the plugs, which are of steel, are dipped in a graphite wash between each cast to preserve their shape; even then they do not last so long as the die. The other illustrations represent chiefly different types of carbon brush-holders, all of which are being die-cast on a commercial scale. The design of the die is a most important factor, and here it is where experience is the best guide. The design of the part itself should conform to the special requirements of die-casting, and there is need for the closest co-operation between the engineer, metallurgist and foundry foreman. The number and shape of the parts of the die, method and order of withdrawing the cores, venting, location, shape and size of the gate, all must be carefully considered in designing a new die.

Cost of Process

No general rule can be laid down with regard to costs. In some cases die-casting is cheaper, in other cases dearer than sand-casting. The cost of dies, material, labor and machining must be investigated before a decision can be reached as to which is the most economical process. The cost of machining and assembling the butterfly type brush-holder referred to is eight times as great when sand-cast as it is when die-cast, and the other parts shown are also cheaper die-cast. The castings are not sold by weight, as the cost of labor varies both in making the dies and castings. The die cost is treated as a separate item from that of the castings, and is generally borne directly by the customers.

Die-Casting on a Scientific Basis

For a scientific investigation into die-casting, the following might be carefully studied:

The alloy:

(1) Coefficient of expansion at different temperatures.
(2) Specific heat.
(3) Thermal conductivity.
(4) Mechanical properties at high temperatures.
(5) Mass, volume and surface area of casting.
(6) Latent heat of fusion.
(7) Metallography.
(8) Pressure on metal in die.

The die-material:

(1) to (5) As indicated by the foregoing.
(6) Possible attack by molten alloy.

Casting conditions:

(1) Temperature of molten metal.
(2) Temperature of die.
(3) Length of time in die.
(4) Rate and method of cooling and casting.

Even with all the foregoing information it would still be necessary, in the case of a new part, to adopt more or less empiric lines before a satisfactory casting could be produced. It might be feasible to design a standard die which would serve as a basis for comparison of results obtained by different observers with various castings.

Crucibles Manufactured With American Clays

THE literature on crucible manufacture is not very extensive and the contribution on this subject by A. V. Bleininger, of the United States bureau of standards, Pittsburgh laboratory, in a paper before the American Institute of Metals, reveals many facts of interest to brass and crucible steel foundrymen. He points out that graphite crucibles consist essentially of a mixture of graphite and clay and are fired to a moderate temperature, usually at or below 950 degrees Cent. The properties of the graphite which render it so valuable in connection with this use are its refractoriness which, to a certain extent, is imparted to the clay bond, its reducing effect which prevents the oxidation of the metal and its high thermal conductivity which makes possible rapid fusion of the charge. In addition, the smoothness of surface which it imparts to the crucible permits the clean pouring of the metal.

The function of the clay is that of a bonding material which makes possible the shaping of the crucible and the cementing together of the graphite flakes, at the same time covering the particles, thus protecting them from oxidation. In order to be most effective it is necessary that the clay contracts and becomes dense at as low a temperature as is consistent with the required refractoriness.

Method of Manufacture

The manufacture of graphite crucibles consists in thoroughly grinding together and blending the graphite and clay, tempering with water in a suitable mixing machine until the mass has assumed the proper plastic consistency, shaping the crucibles by means of a pottery jolly, drying and finally burning them.

It might be well to consider somewhat in detail the two essential raw materials, the graphite and the clay. The modification of carbon known as graphite has been defined as that allotropic form which has a specific gravity of from 2.25 to 2.26.

In European practice both coke and retort graphite have been admixed with the natural graphite for making crucibles. This practice is not desirable for steel melting since the amorphous forms of carbon are more soluble in the molten metal than crystalized graphite and hence cause too much cementation. Their more rapid rate of oxidation is likewise detrimental for this purpose.

Some of the Birmingham crucibles

are said to be made up of three parts (by weight) of graphite, two of hard coke, two of Stourbridge clay and one of ground sherds from old crucibles. Crucibles used in a German foundry have been made from a mixture consisting of five parts of ground coke, four of graphite and eight parts of Stourbridge clay and grog. If the necessity arose it would be, of course, possible to use crucibles in which all the carbon is introduced in the form of retort carbon, coke or electric furnace graphite, even though the results were not as satisfactory as those obtained with the natural graphite.

Bond Clays for Crucibles

Up to the beginning of the present war the clay used almost exclusively as a bonding material for graphite crucibles was that from Klingenberg, Bavaria. This clay is of a dark-bluish color and possesses marked plasticity and bonding power. When made up with water it is of *sticky* consistency and is capable of cementing together a large volume of nonplastic material such as graphite, to form, upon drying, a tough, strong body. It has been claimed by Scheid that the structure of the clay grains resembles that of fine mica, showing crystalline forms or fragments of such. This scaly structure, approaching that of graphite is thus said to bring about a condition of strong cohesion between the two materials. At the same time the clay appears to be quite high in organic matter. Unmixed with nonplastic material it has a decided tendency to check and crack in drying. There are several grades of this clay which differ somewhat in their properties, and when marketed it does not possess the uniformity of composition which has been claimed for it.

From the analysis of the Klingenberg clay made in this laboratory it appears that it is composed of about 80.64 per cent of clay substance, 12.86 per cent of fine quartz and 6.50 per cent of feldspar. In addition to its excellent plasticity and binding power this clay possesses the property of burning to a dense structure at a comparatively low temperature, about 1125 degrees Cent., thus enveloping and protecting the graphite from oxidation. Furthermore, it is quite refractory showing no decided softening at temperatures up to 1400 degrees Cent. When admixed with graphite its resistance to high temperatures is increased still more and it begins to soften only when the graphite is burned away in larger quantities. It is quite likely that at the maximum furnace temperatures silicon carbide is formed due to the reaction between the silica of the clay and the graphite. The green patches sometimes observed on graphite crucibles would tend to indicate such a condition.

The work done by us seems to indicate that in using American clays somewhat higher percentages of bond should be used. Thus a brass crucible composition consisting of 35 per cent plastic clay, 45 per cent chip and lump graphite, and 20 per cent ground old pots might be changed to 35 per cent plastic clay, 5 per cent kaolin, 45 per cent graphite and 15 per cent old pot material. Similarly, a steel crucible mixture composed of 55 per cent graphite, 32 per cent plastic clay and 13 per cent sand, might be changed to 30 per cent plastic clay, 5 per cent kaolin, 53 per cent graphite and 10 per cent sand. In tempering crucible mixtures with water, the softer the consistency, the better should be the development of the bonding qualities. If it were practically feasible it would be desirable to use so much water that the mixture would form a viscous, liquid slurry.

The differentiation between crucibles used for brass and for steel melting as to composition is not yet as clearly defined as it might be. All agree, however, that the clays need not possess as low a vitrification temperature, but a higher overfiring temperature and greater refractoriness when used for steel melting. It also would be presumptuous to say that we understand all the factors entering into the construction of the crucible body, nor do we understand clearly the various destructive agencies tending to shorten the life of the crucible. The subject is not as easy as it might appear to the uninitiated.

Workmanship a Vital Factor

It is obvious that laboratory work along these lines is difficult to carry on without having access to a crucible plant as the question of workmanship enters vitally into the testing out of the different mixtures. Much is yet to be learned. It is believed, however, that the future will show that the application of ceramic principles, so extensively applied in the production of porcelain and other clay products, are of service also in this connection. The American manufacturers of crucibles have been confronted by a serious situation and they have done well under the circumstances, rendered especially difficult by the prevailing strenuous industrial conditions. There is every reason to believe that they will continue to improve their product and still retain the use of domestic raw materials.

In the use of graphite crucibles it is quite apparent that the treatment to which they are subjected is often extraordinarily severe. In the first place it is doubtful whether the function of drying out the crucibles is properly understood. Graphite crucibles are not fired to a high initial temperature and hence retain a porous structure. In common with all other clay products not burned to vitrification, the crucibles are hygroscopic, in other words, they greedily absorb moisture from the atmosphere, which is more difficult to expel than we generally realize.

Preheating of Crucibles

Low-fired clays differ widely as to their hygroscopic capacity, and the temperature at which they release the moisture thus absorbed. At the same time the expulsion of this moisture requires considerable time. Therefore, it is not sufficient simply to keep the crucibles in a warm place, but they should be finally maintained for at least several days at a higher temperature, say 300 degrees Fahr., before being placed in the furnace. In Europe, the crucibles when removed from the kiln are sometimes covered with a waterproof coat, such as tar or pitch dissolved in turpentine.

The preheating of the crucible just before putting into the heat for the first time, likewise, is often only too abrupt and hence the temperature change to which they are subjected is too violent. The ideal method of handling the fresh crucibles would be to place them in a special furnace kept heated by the waste gases of the melting furnace, where the temperature could be brought uniformly to somewhat below red heat.

Annealing Gray Iron Cylinders

Manufacturers of cylinders for the gasoline engines installed in submarine chasers have found it necessary to anneal the finished castings in order to prevent warping in service. Most of the submarine chasers are fitted with 6-cylinder engines, 10 inches in diameter and 11 inches stroke. The castings are annealed immediately after they are rough turned. A large, semimuffled, oil-fired furnace is used and a temperature of approximately 800 degrees Fahr. is employed. Eight cylinders usually are charged in the furnace at one time. Care must be taken to heat the furnace evenly and the work must be allowed to cool very slowly in order to relieve all casting and machining stresses. Pyrometers check the heating.

Casting a Slide Valve Locomotive Cylinder

A Three-Part Flask is Employed, the Body of the Mold Being Contained in the Cheek—Every Operation Involved in Setting the Cores is Detailed

By R H Palmer

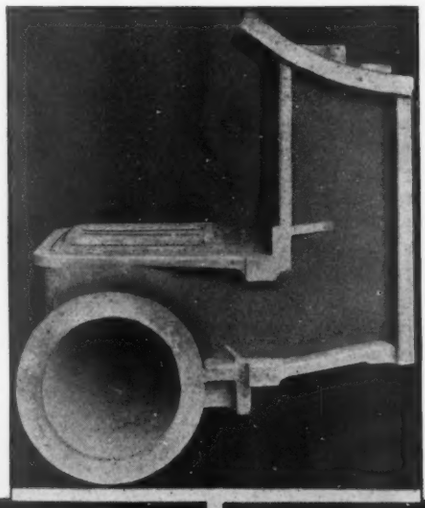
THAT will go down in history as the greatest railroad equipment construction program ever undertaken, has just been initiated by the government It involves the building of more than 2000 locomotives and about 100,000 freight cars. Hundreds of thousands of tons of castings wiN be required and the foundries of this country will be crowded to the limit for many months while they are doing their bit. An attempt to describe all of the operations involved in the manufacture of these castings would take volumes and therefore this article will be limited to a discussion of only one cast part for a locomotive, namely, the slide valve cylinder.

Many years ago it was the practice to cast separate the saddle of the locomotive, that part on which the front end of the boiler rests, while the cylinders were bolted to either side. At that time the weight of the locomotives did not exceed 30 tons. Later development in locomotive construction provided for splitting the saddle down the center, half of the saddle having been cast on each cylinder. While the locomotive contains many cast parts that are difficult to make, the cylinder is the most intricate. Within a generation the weight of cylinders has been greatly increased. The first castings of this kind that I made weighed only 1500 pounds, whereas today the slide valve cylinders that we make in our shop weigh from 6800 to 7400 pounds. Superheater cylinders, to a large extent, are replacing the slide valve type, although a large number of the former are still in use. According to the *Railroad Man's Magazine,* locomotive No. 999, which made a record speed of 112½ miles per hour between Batavia and Buffalo, N. Y., in May, 1893, was equipped with slide valve cylinders. This record has remained unchallenged as the greatest speed performance of a locomotive.

Until recent years, when a cylinder head was broken, the casting had to be scrapped, but with the introduction and development of the welding process, these castings now are repaired at a trifling cost compared with the expense involved in replacing the broken part with a new casting. Heretofore, it also was the practice to bore the cylinders and the piston operated in the bore without bushings. Now all large slide valve and superheated cylinders are bored and bushed and when the bushing is worn out it is easily replaced.

In the accompanying illustrations, Fig. 1 is a side view of a slide valve cylinder casting awaiting shipment to the New York, New Haven & Hartford railroad. Fig. 2 shows the steam entrance and exhaust parts and Fig. 3 is a view of the cylinder casting, the reverse of that of Fig. 1. The pattern is molded in a three-part flask. A section of the pattern on a mold board inside of the cheek flask is shown in Fig. 4. piece *A* of the pattern is loose on the main part of the pattern *B* and is left off during the initial ramming operations. Sand is rammed up to the lines *C* and bars *D* then bolted in place. The nuts are on the outside of the flask to prevent the bolts from turning and when shaking-out the nuts are removed and the bolts driven in permitting them to fall out with the sand. Sand then is rammed to the line *E,* Fig. 4(and the loose part of the pattern *A* is placed on the main pattern *B,* being weighted to prevent it from raising when sand is rammed underneath part *F* of loose piece *A.*

When the sand is rammed to point *G,* loose piece *A* is removed and rods are driven into the sand to strengthen the mold. A fillet then is formed and is nailed at *H,* Fig. 4. The drag half of the flask then is set



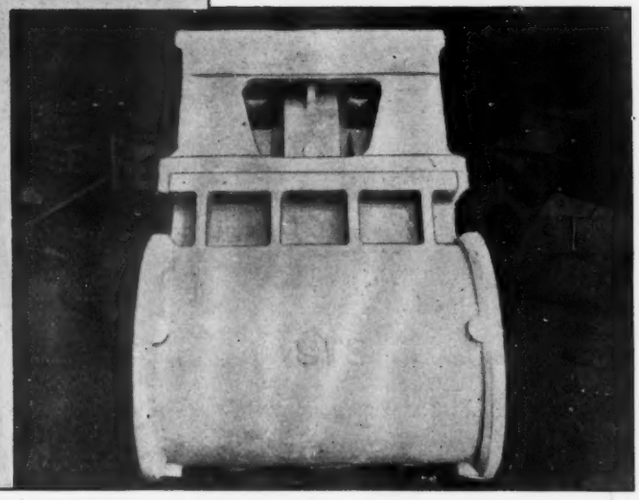


FIG. 1—SIDE VIEW OF A SLIDE VALVE CYLINDER CASTING READY FOR SHIPMENT

FIG. 2—CYLINDER SHOWING STEAM ENTRANCE AND EXHAUST PORTS

FIG. 3—LOCOMOTIVE CYLINDER CASTING SHOWING BOTTOM SIDE OF FIG. 1

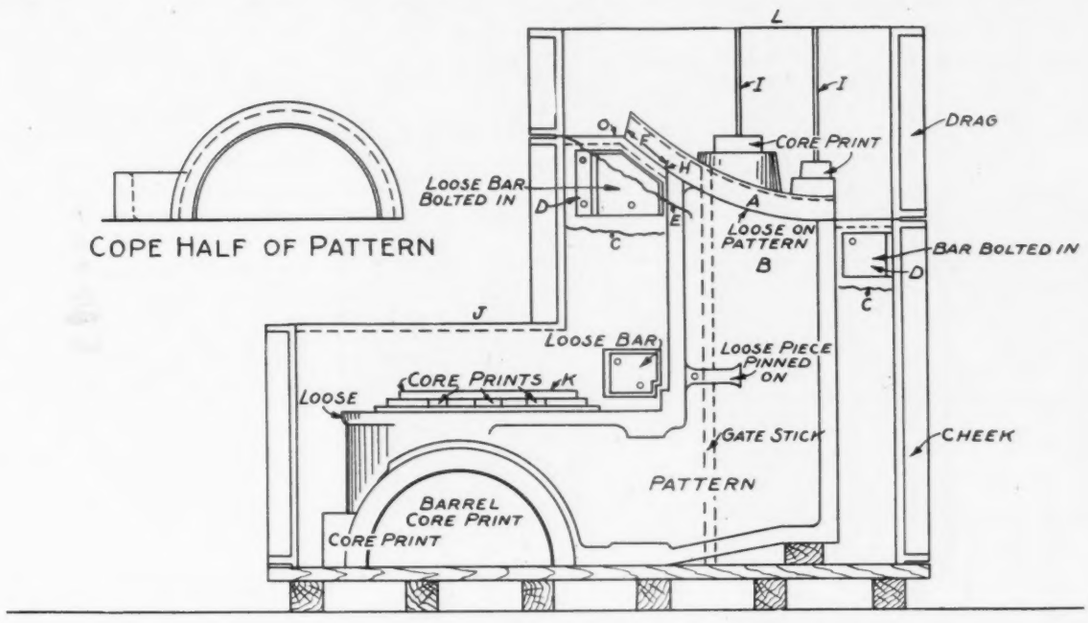


FIG. 4—PATTERN ON MOLD BOARD INSIDE OF CHEEK FLASK

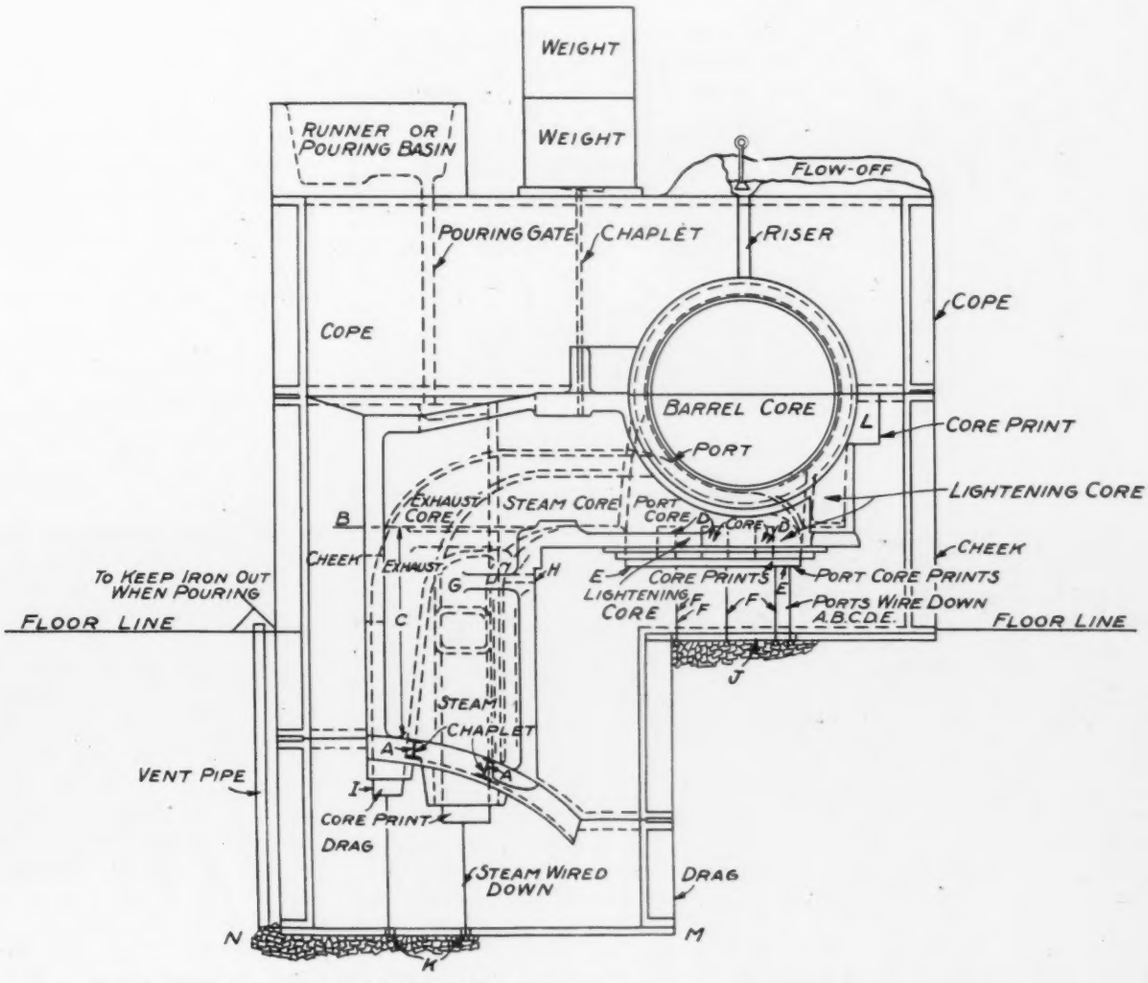


FIG. 5—SIDE VIEW OF LOCOMOTIVE SLIDE VALVE CYLINDER MOLD AND PATTERN

on the cheek and rods *I* are rammed in position. The bottom board that is placed over the cheek at *J* is slotted, the opening coinciding with the port core print *K*, thereby providing vents for the gas and openings for wiring the port cores.

After the cheek and drag parts of the mold are bolted together, they are rolled over and the cope section of the pattern is set in position and rammed, as shown in Fig. 5. The cope part of the mold then is removed, the pattern is drawn and the cope mold is finished. The pattern next is drawn from the cheek and loose piece *A* is removed. The drag then is finished and nailed, the latter operation being necessary since this part of the mold contains a number of pockets as shown at *A*, Fig. 2. The mold then is assembled and bolted and is dried in an oven overnight before coring.

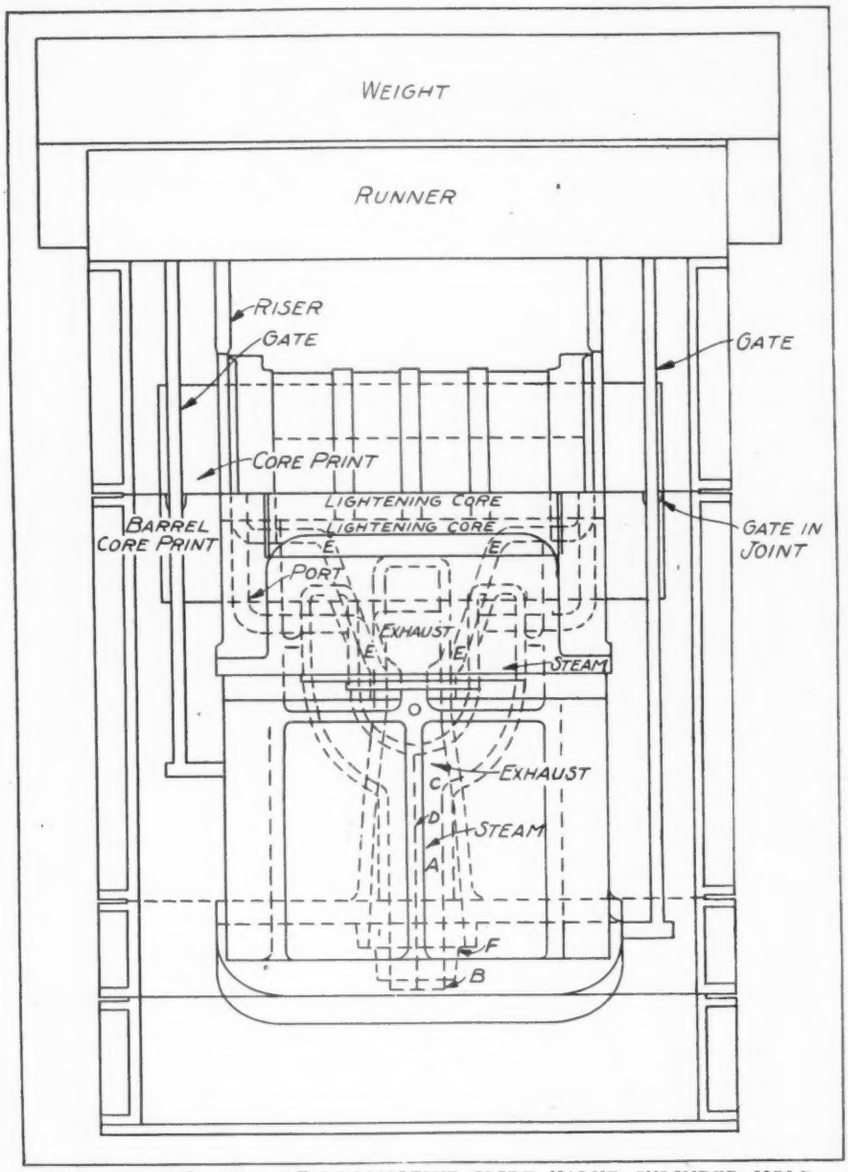


FIG. 6—FRONT VIEW OF LOCOMOTIVE SLIDE VALVE CYLINDER MOLD WITH CORES IN PLACE

The following morning the cheek and drag are set in position for coring. The lower inside core *A*, Fig. 5, is set on chaplets and extends up to about the line *B*, forming a part of the inside of the casting. Lightening cores *D*, Fig. 5, then are fastened in place, which form the openings *C*, Fig. 2. Steam port cores *A*, Figs. 6 and 7, then are set. In Fig. 6, the steam pipe core *A* is shown extending from core print *B* to *C*, where it branches down into core-print *E*, Fig. 5. These are two cores joined on the dotted line *D*, Fig. 6. The production, pasting and finishing of this core requires skill, since the two port cores must be joined into one so that the port ends shall enter the proper prints. The cores must be gaged when pasted, since a variation of ⅛ inch necessitates pasting over. The port cores *E*, Fig. 6 are placed on a line with the prints *E*, Fig. 5, and are pasted in place. Wires *F*, Fig. 5, are extended through and attached to the bottom board to hold down the port cores also shown at *B*, Fig. 7. A core *G*, Fig. 5, forms a curved surface in the hollow of the steam core and is held in place by a chaplet, venting at *H*. This core makes the opening D, Fig. 2.

The exhaust core *I*, Fig. 5, then is set. At *C*, Fig. 7, this core is shown extending down between the port cores into a print on a line with *E*, Fig. 5. This core makes the exhaust opening *E*, Fig. 2, while the port cores *B*, Fig. 7, make the openings *B*, Fig. 2. The port cores form the passageways for the steam to enter the cylinder from the steam chest, exhausting through a valve into the exhaust pipe. An enlarged view of the port core is shown at *A*, Fig. 8, on the opposite page.

Setting Lightening and Barrel Cores

The lightening core *L*, Fig. 5, then is set, followed by the barrel core, shown in Figs. 5 and 9. At the right and left of Fig. 9, port cores are shown at *B* and *A*. Fig 8 illustrates how the port core *A* is curved to receive the barrel core. These port cores must be well rodded, firmly bonded, well vented and thoroughly baked, and when the barrel core is set care must be exercised to prevent the barrel core from bearing too hard on the port cores. In casting, I prefer to have a fin form between the port and barrel cores, as a slight settling of the barrel core may crack a port core. In making and handling dry sand molds it is well to remember that "a fin is better than a crush". Green sand will yield, but dry sand will crush. The lightening core *C*, Fig. 9 is set next. While the steam, exhaust and port cores are vented at *J* and *K*, Fig. 5, the vents from the lightening cores forming the inside of the saddle part of the cylinder casting and the outside walls of the steam pipes, are brought up through the lightening core *C*, at *D*, Fig. 9. The cheek and drag section of the mold then is lifted and wires *F*, Fig. 5, are drawn taut and wedged to the bottom board. The wires holding down the steam and exhaust cores also are fastened at *K*, as will be observed from Fig. 5.

The cheek and drag part of the flask then is lowered into a pit and sand is rammed around the flask from *N* to *M*, Fig. 5. The cope then is tried-on, and after lifting off, a flame from an oil torch is applied to dry any paste that has been used. Chaplets should be employed as sparingly as possible, particularly for supporting cores forming live steam openings, as the metal in these parts is subjected to great pressure. On the other hand, chaplets may

be employed for supporting the exhaust cores without danger of injuring the strength of the casting. All of these castings must be made to specification, their chemical and physical properties being prescribed by the railroads. Test bars cast from the same metal as poured into these cylinders developed transverse strengths of from 3600 to 4400 pounds.

Making Core Mixtures for Steel Castings

Question:—We would like to obtain core mixtures for steel castings suitable for both light and heavy work.

Answer:—The sand ordinarily employed for making cores in iron and brass foundries cannot be used for cores for steel castings, because they do not satisfactorily resist the high temperatures of this metal. Therefore, it is necessary to employ silica sand which is highly refractory and should contain a very high percentage of silica. Small cores which must be handled green should be made from a mixture of fire clay and silica sand which will give the core strength before baking. A typical mixture follows: Silica sand, one wheelbarrowful; fire clay, three level shovelfuls, and flour, three level shovelfuls. This should be mixed thoroughly in a pan mill. The amounts of flour and clay may be varied until a suitable mixture is obtained for the work to be done. It also is customary to use molasses water to wet the sand to the proper temper. Whenever it is possible to make cores without the use of clay, this is desirable, because the cores then will be more refractory and will produce smoother openings in the castings. Starch binders also make excellent cores when used in the proportions suggested by the makers and a large number of core binders for steel foundry work also are advertised in THE FOUNDRY. Cores for steel castings should have a smooth skin and, therefore, it is advisable to spray them with molasses water before baking. The core should be of such a consistency that it will offer little resistance to shrinkage, otherwise the casting may check.

An interesting address on the new Stoughton method of using oil for cupola melting was delivered in New York May 25 before the Associated Foundry Foremen of New York and vicinity, by W. S. Dickson, of the Stoughton Process Corp., 71 Broadway, New York City. Owing to the prevailing shortage of coke, the talk proved exceedingly timely as it dealt with a process which involves but a relatively small quantity of this material to secure the best melting results.

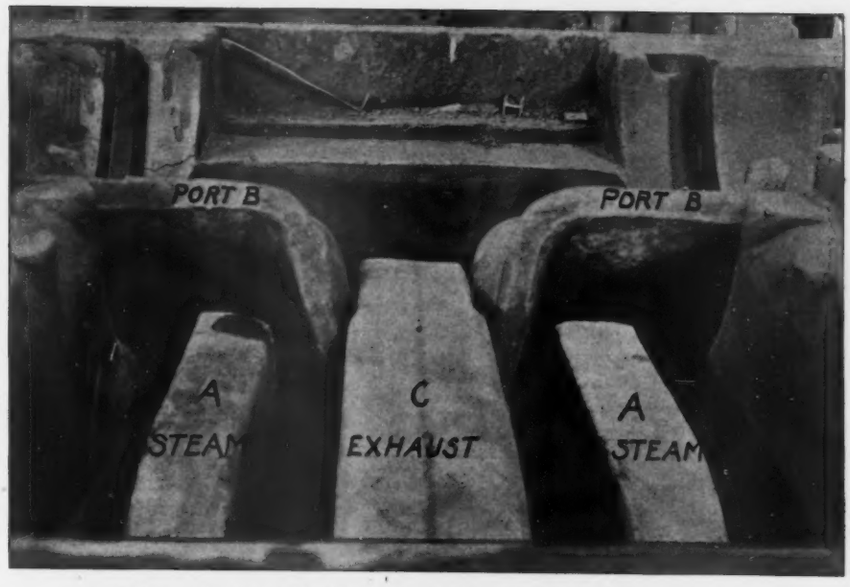


FIG. 7—STEAM, EXHAUST AND PORT CORES IN THE DRAG

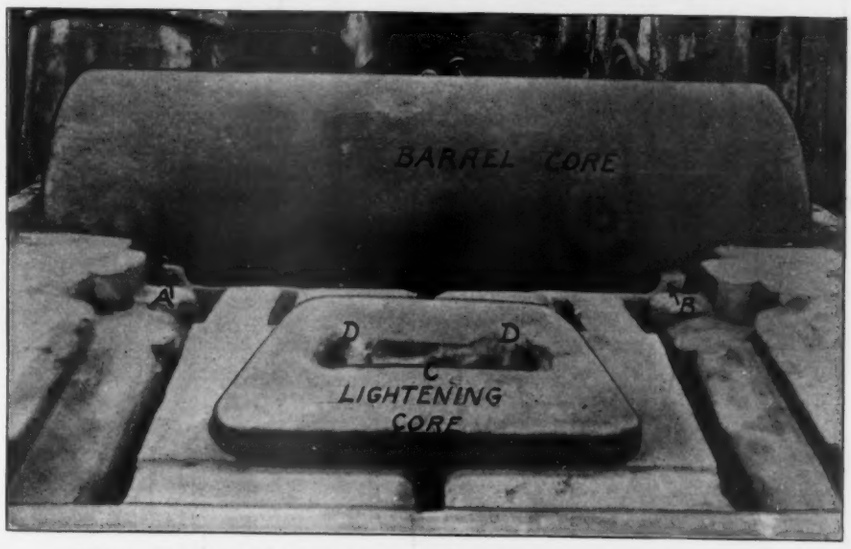


FIG. 8—ENLARGED VIEW OF STEAM, EXHAUST AND PORT CORES

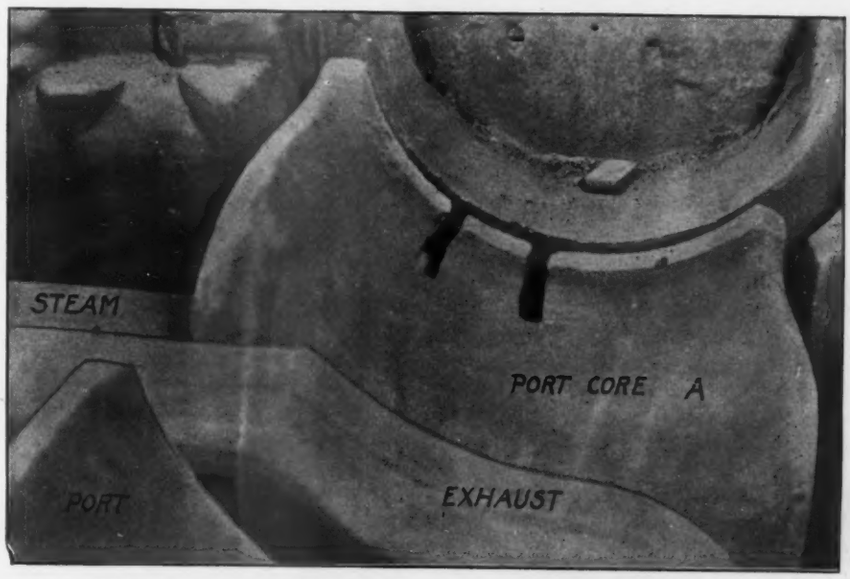
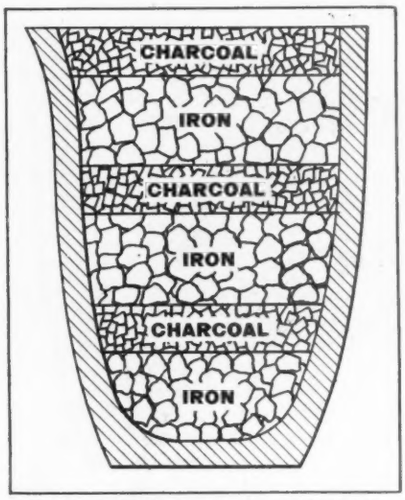


FIG. 9—THE LIGHTENING AND BARREL CORES IN POSITION

Practical Foundry and Pattern Shop Suggestions

Melting Gray Iron in a Crucible—Patternmakers Scale Holder—Novel Chill and Flask—Making a Large Ring Pattern—How Patterns Should be Finished

FREQUENTLY the brass founder is in need of gray iron casting and the method of melting in a crucible is outlined in a bulletin recently issued by the Joseph Dixon Crucible Co., Jersey City, N. J. As shown in the accompanying illustration, alternate layers of charcoal and iron, broken to the size of walnuts or slightly larger are charged in the crucible and the metal may be melted in any brass furnace in which a crucible is used. It should be remembered, however, that gray iron melts at a much higher temperature than brass and, therefore, the material will not be reduced to a liquid state as quickly as non-ferrous metals. The bottom of an old brass crucible should be used as a cover which will protect the metal from gases and also will facilitate the melting operation.

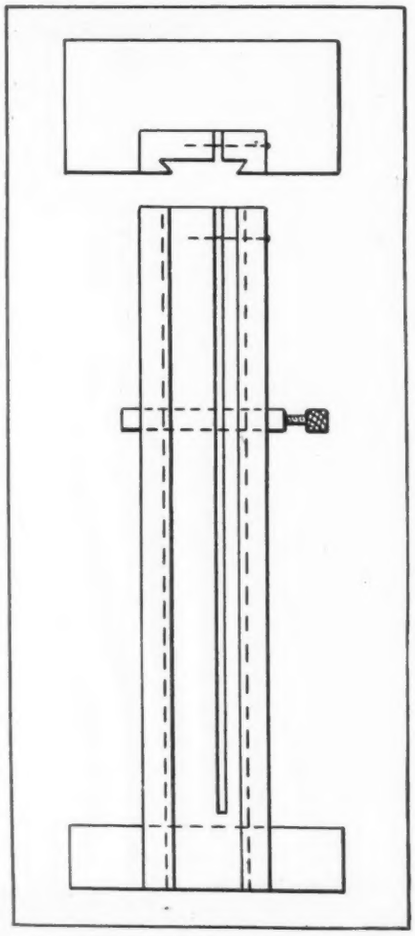


CROSS-SECTION OF A CRUCIBLE SHOWING ALTERNATE LAYERS OF CHARCOAL AND IRON

A Patternmaker's Scale Holder

By S. L. Cook

Many pattern shops use surface gages extensively to lay out various lines and centers. This requires the use of a scale for reference in checking dimensions. If he is to work efficiently, the patternmaker should be able to lay his hands on the scale immediately at any time. To secure this result a holder which retains the scale in an upright position has been found useful. This holder consists of a base block and an unpright grooved supporting member of the same length as the scale. The base is 4½ x 3½ x 2½ inches, or larger if stability requires. The upright member which is cut to the shape shown in the accompanying illustration to accommodate the scale, is 12 x 1⅝ x ¾ inches. A dovetailed groove is formed to fit the scale loosely and a slot also is sawed in an off-center position from the top nearly to the base of the upright. A brad is placed through the edges, as shown, to keep the two sides in alignment. The upright is nailed securely to the base and a small clamp is applied to spring the two parts together against the scale when it is placed in the dovetailed groove.

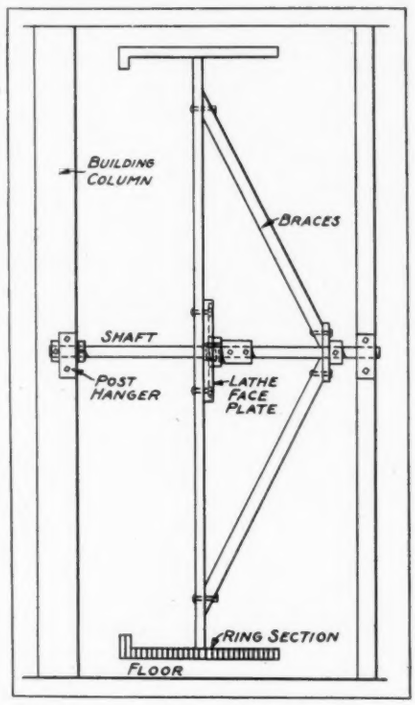


PATTERNMAKER'S SCALE HOLDER

Making a Large Ring Pattern

By J. L. Gard

Making the pattern for a ring, 15 feet in diameter and 42 inches deep, taxed the capacity of our plant, but by exercising a little ingenuity the pattern was made and the rigging improvised proved of value for other work of a similar nature. This ring, in addition to its large size, was flanged on the inside and had several projections and lugs, both inside and outside. These, however, were produced by cores rammed in the mold. Our lathe was of insufficient capacity to swing a pattern of this size and, therefore, this rigging had to be improvised. The materials included an 8-foot shaft, 2⅞ inches in diameter, two post hangers, two set collars and a flange, 15 inches in diameter, which was bored to fit the shaft. This was provided with set screws and on it eight holes, ⅝-inch in diameter were drilled in a 12-inch circle. A casting then was produced, which was 10 inches long and was flanged at about the center of its length. It was threaded to take a 24-inch face plate from the lathe, which was screwed against the flange. This casting was bored to a close fit with the shaft and two 1-inch set screws held the two parts in position.



SPECIAL RIGGING IMPROVISED TO SWING A LARGE RING PATTERN

An 18-foot post, 6 x 8 inches in dimensions, was secured firmly between the floor and ceiling girder, a distance of 6½ feet from one of the columns. Post hangers were bolted to the column and the post at a height of 8 feet from

the floor to the center of the shaft. The 15-inch flange was placed on the shaft 18 inches from one end and the lathe face plate was located 28 inches from the other end of the shaft. The shaft was then set into the hanger, collars having been provided as shown in the accompanying illustration. Eight wood arms, 2¼ x 5 inches x 7 feet 4 inches were bolted to the face plate and eight diagonal braces, 2 x 4 inches were bolted to these arms at a point 6 feet from the center of the shaft to the 15-inch flange on the other end of the shaft.

The shaft was then turned slowly by hand and the arms were marked to a diameter ⅛-inch less than the finished inside diameter of the ring. The arms then were cut off carefully to this line. Segments, eight to a circle, then were cut to this diameter inside, and ⅜-inch more than the turned outside diameter of the ring. A complete circle then was built the end of each segment being screwed into the ends of the arms. Another circle then was built, the joints of which were lapped with the first ring. These segments having been carefully cut and fitted, made a fairly true circle. A belt from a motor was passed around this ring. The two courses of segments were trued by an operator who was located on a platform, a slight crown having been provided for the belt and the edges were turned for a joint. We then were able to keep building up each side onto this ring turning the inside as it was built-up until the required depth was attained. The outside of the ring merely was a job of straight turning. The only special equipment required included the sleeve for the face plate, the 15-inch flange which was bored and drilled and a platform for the floor rest and operator.

Novel Chill and Flask Save Time

By L. W. Redshaw

Sprocket wheels used in chain-belt mechanism are seldom machined. Instead the manufacturer depends on the foundryman to cast the teeth with sufficiently accurate contours to serve all practical purposes. At the same time, the teeth must be protected against wear, and therefore they usually are cast in a chill.

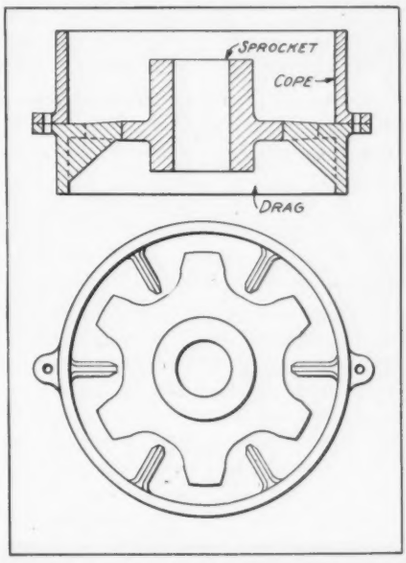
A combined cast iron chill and flask for handling work of this character is shown in the accompanying illustration. This flask is inexpensive, easy to make and has been thoroughly tried out. The chill and drag form one piece. As it is necessary to make the flask as light as possible and at the same time insure rigid construction, the drag is ribbed under the projections that chill the sprocket teeth.

Only the working faces of the teeth are chilled, but the entire tooth surface may be chilled by adding metal above and below the space occupied by the teeth. This metal can run as far toward the center of the flask as it is desired to chill the casting. In this case the parting should occupy the same position as in the flask shown in the accompanying illustration. It should be remembered, however, that sprocket teeth are never very thick, and it is seldom necessary to chill more than the outer or wearing surfaces.

How Patterns Should be Finished

By M. E. Duggan

Recently one of the apprentices in our shop made inquiry regarding the different grades of finish applied to various patterns. Some of these were given two or three coats of varnish while other models were delivered to the foundry without being sandpapered or varnished. I recall that I had made a pattern from which only one casting was poured and since about 140 feet of select lumber were used in its construction, which, of course, could be employed again in making other patterns, this model was delivered to the foundry in its apparently unfinished condition as regards paint or varnish.



COMBINATION CHILL AND FLASK FOR SPROCKET WHEELS

Two or more coats of spirit varnish add to the appearance of a pattern, increase its durability by imparting a hard surface impervious to water and produce that smoothness so essential for its proper withdrawal from the sand. Also, a nicely finished pattern is handled with greater care in the foundry and pattern storage than models that are not so highly finished.

Of course, there are instances when it is necessary to finish a pattern in a first class manner for only one casting, yet the model is kept in storage since it may be returned to the foundry in a week or a month. In a case of this kind it is essential that the pattern is properly finished to avoid damage from conditions that may arise in storage.

Excess Labor Costs

Frequently the pattern shop is blamed for excess labor costs, whereas the fault really is chargeable to the designer or draftsman. Recently two patterns were ordered for reciprocating printing press tables. These were of lattice design and the only differences in the two patterns were the overall dimensions and a slight variation in the depth of the ribs. One blue print of the pattern was delivered to the company's own shop and the other to a jobbing shop. The drawings showed an extra large radius at the four corners, the edges of the ribs were nicely rounded and fillets were indicated in every corner and angle where it was possible to provide them. The ribs were tapered from ⅜ to ¼-inch in 3 inches and other unnecessary details were included in the drawing that greatly added to the labor and expense of pattern production. The details just mentioned I ignored entirely in the construction of my pattern. I knew the requirements of the company for which this pattern was to be made and the model was constructed accordingly. On the other hand, the pattern built by the jobbing shop was produced according to the drawing at a greatly increased expense over the pattern made in my shop. However, the jobbing patternmaker was justified in making the pattern in this way since he was following the drawing as to details which were supposed to govern.

Patterns for castings artistic in design and with rounded corners, filleted angles and fine finish require the best of materials, excessive and more than ordinary cost in their production, yet in a great many instances this extra labor is unnecessary, particularly when only one or two castings are made from the pattern. Draftsmen should be familiar with all of the factors involving pattern production since it is not a part of the patternmaker's duty to decide what should be put on or left off the pattern. The rounding of corners, filleting of angles and the artistic finishing of patterns, in a great many instances, involve a greater expense than the construction of the pattern itself and cause delays in the delivery of the pattern to the foundry.

A New Gas Fired Furnace for Refining Iron

Details of Refining Medium Developed for Preparing Metal for High Grade Castings for Ordnance Work and Other Purposes

By George H Manlove

A STATIONARY reverberatory melting and refining furnace used for some time in nonferrous work has been applied to the melting and refining of iron by Edward H. Schwartz, Chicago. The initial installation is at the plant of the Garden City Foundry Co., Archer avenue, Chicago. The products obtained are called refined deoxidized semisteel, refined deoxidized semimalleable and gray iron. The furnace is operated in connection with a cupola which performs the primary melting.

The furnace is cylindrical with cast steel ends and steel plate walls. It is 6 feet 6 inches in diameter and 10 feet long, and is lined with firebrick to a thickness of 10½ inches. A removable bottom 4½ inches thick extends above the slag line. This bottom consists of chrome, silica or magnesite brick as neutral, acid or basic effects are desired.

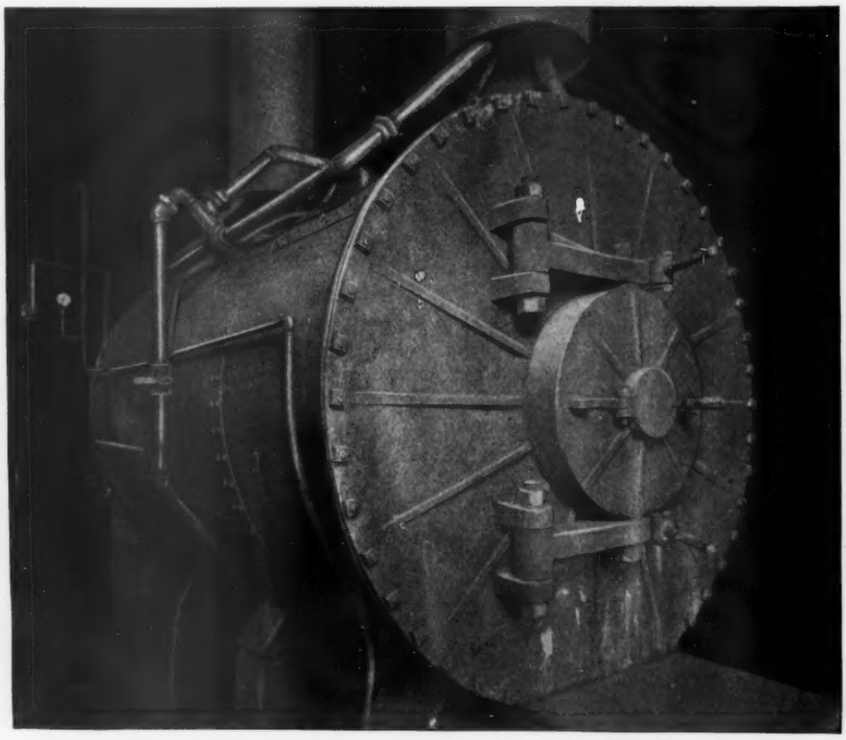
The charging door, in the center of one end, is circular. It is mounted on hinged arms and its machined face fits accurately, avoiding the necessity of clay luting. A smaller door in the center of the charging door covers a peep hole through which progress of the refining operation can be readily observed. This arrangement is clearly shown in the accompanying illustration. In the center of the end opposite the charging door an aperture is left for inserting a lighter to ignite the gas at the beginning of the process. This aperture is luted shut after the flame has been started. A testing door and slag hole are fitted on one side. Two vents are placed in the top, one near each end, with a vent hood and short stack. The waste heat from the furnace passing up these stacks preheats air passing down through pipes leading from the outer air to the gas burner. The current of air in these pipes is maintained by the vacuum action of the burner, which has 5 per cent of compressed air supplied to it. The burners, it is said, are under absolute control by one valve.

Three burners are placed in the top of the furnace. One, in the apex of the arch, carries only preheated air. The other two are 45 degrees from the apex, in line with the first, and carry mixed gas and air. The currents from the three meet at the center of the furnace. It is claimed that temperatures of 5000 degrees Fahr. have been obtained.

In the installation shown in the accompanying illustration, the furnace receives iron direct from a 54-inch cupola, the spout from which enters the furnace at one side. Scrap is used almost entirely and often no pig iron is employed in the mixture.

In making the deoxidized semisteel, steel scrap is charged in the cupola with a small percentage of spiegeleisen to aid in picking up carbon from the coke. This alloy also assists in deoxidizing, and supplies manganese in addition to fixing some carbon. In order to supply the proper amount of silicon, ferrosilicon is added after the metal is transferred to the Schwartz furnace. There is a small refining loss of ferrosilicon which is taken into account in proportioning the mixture. Other alloys are added as desired to the charge in the furnace at the beginning of the refining process. An hour of refining is sufficient. A tensile strength of 50,000 pounds per square inch has been obtained in a bar machined from the center of a casting.

Steel is produced by charging steel scrap with spiegeleisen in the cupola. Some of the sulphur is removed in the refining furnace by the formation of manganese sulphide. Additions of manganese and silicon are made at the end of the heat. Sulphur and phosphorus also are eliminated in the furnace by the addition of limestone to form a slag. Malleable iron is made by charging steel scrap and spiegel in the cupola with additions of silicon in the refining furnace in the form ferrosilicon. Deoxidized semimalleable refined iron is produced by charging malleable scrap and spiegel in the cupola. Silicon and alloys are added in the furnace during the refining process. It is said a tensile strength of 41,000 pounds has been obtained in an unannealed machined bar. The metal may be hammered like



FURNACE FOR REFINING CAST IRON

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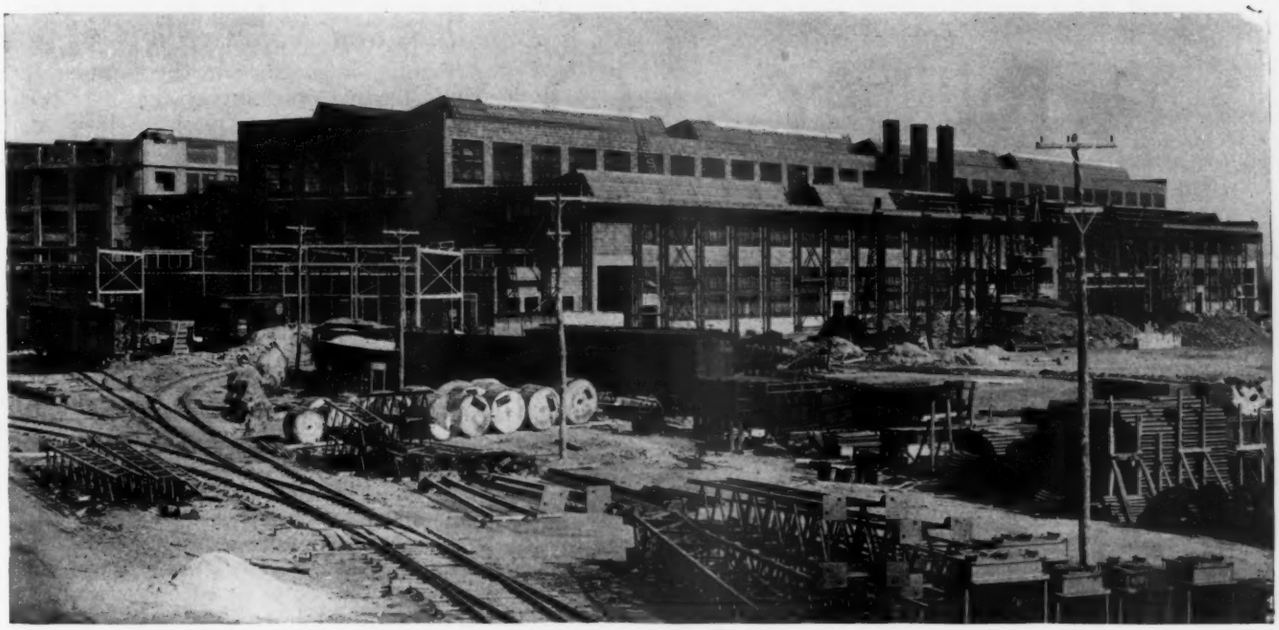

Fig. 1—Where Castings for Some of Uncle Sam's Marine Turbines Will Be Made. This Foundry Has Been Built for this Class of Work Exclusively

Will Make Marine Castings at Philadelphia

UNPRECEDENTED demands on the part of the government for marine equipment has made it necessary for the Westinghouse Electric & Mfg. Co., Pittsburgh, to increase its facilities for producing castings that enter into the production of ship-propulsion machinery. The company has equipped a modern plant for the complete manufacture of marine turbines at Essington, a suburb of Philadelphia, on a site comprising 500 acres. So far there have been erected seven buildings among which is a large gray iron foundry.

An exterior view of this building is shown in Fig. 1. In designing this foundry, special attention was given to the factor of lighting. As the illustration shows, the rectangular type of monitor roof with inclined skylights was decided upon, while side lighting is derived from steel sash windows of ample capacity.

The interior of the foundry is shown in Fig. 2. The building is divided into three bays. The center bay, under the monitor, is free from all obstructions and it is served by electric traveling cranes which traverse the entire length of the building. This bay is used for making molds for heavy castings while the side bays take care of the lighter classes of work, the core rooms and current storage of patterns and castings. Three cupolas assure an ample supply of iron at all times, which is conveyed to any point in the center bay by the traveling cranes shown in Fig. 2.

(Concluded on Page 286.)

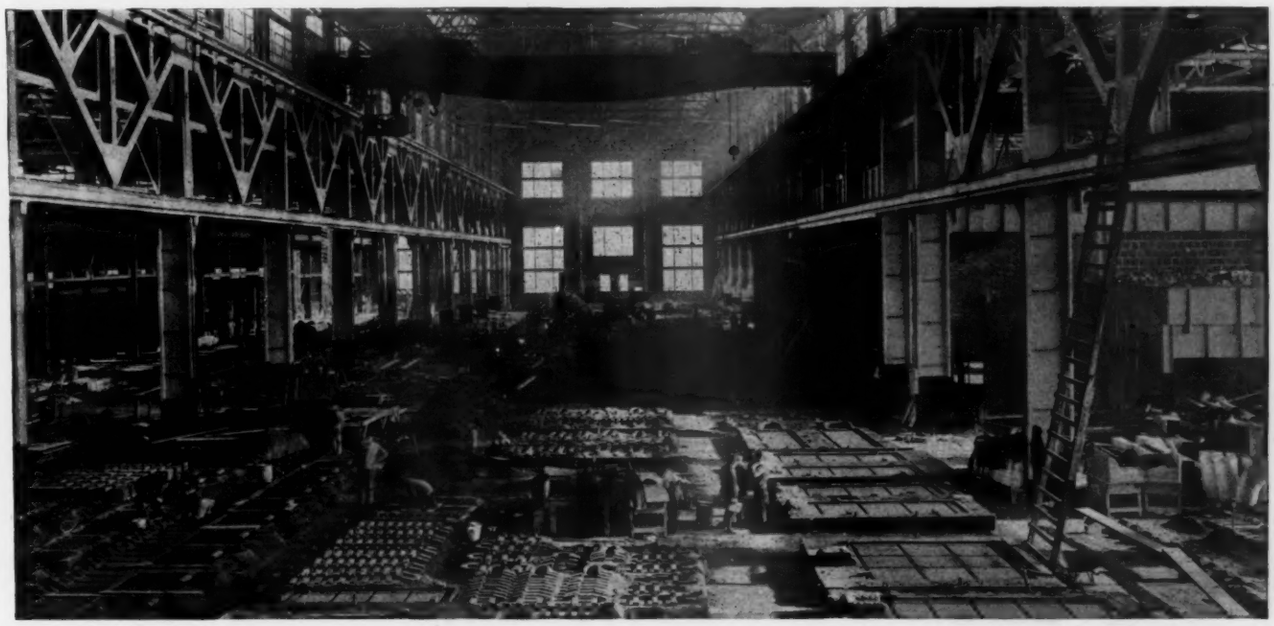

FIG. 2—LARGE CASTINGS REQUIRE PLENTY OF METAL. IN THIS FOUNDRY THE IRON IS CONVEYED TO ANY PART OF THE CENTER BAY BY TRAVELING CRANES

THE FOUNDRY

A monthly journal devoted to all branches of the foundry trade

Published by

The Penton Publishing Co.

Penton Building, CLEVELAND

BRANCH OFFICES

BIRMINGHAM, ENG.....Prince's Chambers
CHICAGO.....1147 Peoples Gas Bldg.
CINCINNATI.....128 Opera Place
NEW YORK.....90 West Street
PHILADELPHIA.....1316 Land Title Bldg.
PITTSBURGH.....2148-49 Oliver Bldg.
WASHINGTON, D. C.....40 Metzerott Bldg.

SUBSCRIPTION

United States and Mexico.....$1.00 a year
Canada.....$1.50 a year
Great Britain and other Foreign Countries Eight Shillings
Single Copies.....15 cents

Copies published three months or more previous to date of current issue, 25 cents each.

ADVERTISING

All communications relating to advertising copy, discontinuances, etc., must be received on the 10th of the month preceding date of publication.

Entered at the Post Office at Cleveland as Second Class Matter

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Essentials and Nonessentials

OF far-reaching importance to the foundry industry is the pig iron survey that has been instituted through the American Iron and Steel institute. It has been prompted by the pig iron shortage which promises to become more acute as the government's war program progresses and the results of this investigation will point the way for the distribution of the available iron supply to prevent any delay in the construction of ordnance, the building of ships and all other essentials necessary to the prosecution of the war. However, this must not be construed as meaning the elimination of all nonessentials. Whatever surplus tonnage of pig iron remains after the foundries engaged on both direct and indirect government work have been supplied will be apportioned among the shops engaged in the production of castings for those industries that are defined as nonessential. Every effort will be made to speed-up pig iron production to prevent as little injury as possible to the plants not engaged on war work, but to what extent their melt will be curtailed is impossible to forecast. Statistics of pig iron output the first four months of this year show a decline in production of 1,190,000 tons as compared with the same period in 1917. It is doubtful, even with accelerated operations, if this shortage can be overtaken, although more stacks now are in operation than at any time this year. The April production was the highest in 11 months and showed a gain over March of 5 per cent. The pig iron output to May 1 this year was 11,203,637 tons as compared with 12,393,648 tons the first four months of last year. It is evident, therefore, that the nonessentials must suffer to some extent. Although we have been at war more than a year, this is the first time in that period that the foundry industry even has been threatened to be placed on a war basis. All other considerations now must be relegated to the needs of the war, and whatever changes this entails must be borne cheerfully with a will to win. The casting trade of the country, although not given as much prominence nor in the spot light as much as the steel industry, is equally as important a factor in meeting the requirements of the government in this great emergency. Iron, steel, malleable and brass castings enter into the construction of almost every engine of war, whether in use on the battlefields or behind the lines. Nearly 100 per cent of the steel casting output already has been enlisted for government work and the gray and malleable iron foundries will receive a constantly increasing volume of business, either directly or indirectly, from government sources. It is estimated conservatively that 500,000 tons of castings will be required in the construction of the 100,000 freight cars and more than 1000 locomotives that have been ordered for the railroads. To this must be added the ever-increasing tonnage of castings for the equipment of ships and their power plants, for ordnance, shells of all kinds, grenades, etc. All of the machinery required to produce this material largely represents the output of the foundries, and with new plants springing up overnight in all parts of the country the machinery shops will be more actively engaged than ever before. It is apparent, therefore, that the volume of essential tonnage will constantly increase over a period of six months at least, and the dislocation of business will not be severely felt by the foundry industry.

Personal

Fred Clausen is now factory superintendent of the Independent Pneumatic Tool Co., Aurora, Ill.

Arthur Hough has become affiliated with the Duriron Castings Co., Dayton, O., as consulting chemical engineer.

R. A. Fairburn recently succeeded August Hechscher as director of the Central Foundry Co., New York, upon the latter's resignation.

C. B. Pritchard was recently appointed superintendent of the Marion Machine, Foundry & Supply Co., Scottdale, Pa.

N. M. Garland, district manager of the Ohio Brass Co., Mansfield, O., was recently elected to membership on the board of directors.

Thomas H. Beaulac has been appointed superintendent of the foundry operated by the Union Iron Works, Bangor, Me.

William T. Dunning was elected vice president and general manager of the Chester Steel Casting Co., Chester, Pa., at a meeting of the board of directors held recently.

George S. Tontrup, general manager of the American Car & Foundry Co., St. Louis, was seriously injured in an automobile collision, May 1.

W. S. Raudenbush is now manager of the Juniata Furnace & Foundry Co., Newport, Pa., succeeding R. M. Marshall, who has enlisted in the government's tank service.

Herbert Jackson was recently elected president of the Chicago Pneumatic Tool Co., Chicago, to succeed W. O. Duntley, resigned. He formerly was in charge of the Boston office of the Bethlehem Steel Co.

Archer A. Landon, vice president of the American Radiator Co., Buffalo, has been named director of the division of production of the aircraft board and has already assumed his Washington duties.

David L. Ward, general superintendent of the Federal furnace of the By-Products Coke Corp., Chicago, addressed the Chicago Foundrymen's club at the Chicago City club, May 11, on the manufacture of pig iron.

W. T. Hersher has been made malleable foundry superintendent of the Chain Belt Co., Milwaukee. He formerly was assistant superintendent of the Bridgeport Malleable Iron Works, Bridgeport, Conn.

S. W. Platt has been appointed manager of the Pittsburgh office of Luria Bros. & Co., dealers in iron and steel scrap, Reading, Pa. Mr. Platt has offices in the Park building.

H. N. Oram, foreman patternmaker of the plant of the R. K. LeBlond Machine Tool Co., Cincinnati, has been appointed supervisor of castings and patterns at the new plant of this company, Norwood, O.

Clyde Brooks resigned recently as secretary and manager of the Pittsburgh Iron & Steel Foundries Co., Pittsburgh, to devote his entire time to services on behalf of the government as a civilian at Washington.

Clifford S. Anderson and M. A. Williamson of the Norton Co., Worcester, Mass., manufacturer of grinding wheels, have gone to South America, where the company is conducting an investigation in the Guianas.

H. D. Wright, formerly manager of the San Francisco office of the Brown Hoisting Machinery Co., Cleveland, has been made Pacific coast representative of that company to succeed the Colby Engineering Co. in the northwest territory.

Alfred L. Aicher became connected with the Southwark Foundry & Machine Co., Philadelphia, recently, in an important capacity, having resigned his position as chief draftsman for the F. J. Stokes Machine Co. of that city.

M. L. Lothrop has been appointed assistant factory manager of the Timken Roller Bearing Co., Canton, O. Mr. Lothrop previously was in charge of the steel and tube department of this plant and also has been metallurgist of the Timken company.

Henry D. Miles, president of the Buffalo Foundry & Machine Co., Buffalo, has been made president of that city's chamber of commerce to succeed Archer A. Landon, who has been made assistant to John D. Ryan, head of the aircraft production board.

V. F. Signorelli has resigned as secretary and assistant treasurer of the Southwark Foundry & Machine Co., Philadelphia, to accept the position of office manager and auditor of the Foundation Co., Carpenter-Watkins, Inc., Brunswick, Ga.

Calvin P. Wolfe has been appointed general superintendent of the Manufacturers' Foundry Co. and the L. J. Mueller Furnace Co., Milwaukee, and W. L. Chatfield has been made superintendent of the casting departments of these plants.

F. S. Shields, president of the Cleveland Milling Machine Co., Cleveland, has purchased the American Range & Foundry Co., and will continue the business as the American Foundry Co., Cleveland. His connection with the former company will not be affected.

T. L. Bryce has bought the Litchfield Foundry & Machine Co., Litchfield, Ill. He formerly was its general manager. Associated with him in the purchase are William Baitman, former chief draftsman, and D. H. Sweeney, former works manager.

M. A. Stone, following his resignation as general superintendent of the Wolverine Brass Works, Grand Rapids, Mich., organized the M. A. Stone Mfg. Co., that city, and was elected president. The company will manufacture small castings and stampings.

W. Y. Banks, formerly affiliated with the United Engineering & Foundry Co., Pittsburgh, has become connected with the sales force of the Connellsville Foundry, Machine & Steel Castings Co., Connellsville, Pa., as sales manager of the Pittsburgh office in the Park building.

Harold L. Stevens, Brookline, Mass., was recently elected treasurer of the New England Castings Co., East Longmeadow, Mass., recently organized to make small electric steel castings. For some time Mr. Stevens has been New England manager for the Lackawanna Steel Co., Buffalo.

H. Cole Estep, editorial director of the Penton Publishing Co., Cleveland, and associate editor of THE FOUNDRY, recently addressed the Newark Foundrymen's association, Newark, N. J., on the German interned ships in the United States and the methods used in repairing and fitting them for service under the American flag.

R. F. Harrington, chemist and metallurgist of the Hunt-Spiller Mfg. Corp., Boston, addressed the regular monthly meeting of the New England Foundrymen's association, Boston, May 8, on "Foundry Molding and Facing Sand Problems". Mr. Harrington discussed the selection, separation and reclamation of foundry sands.

Stuart B. Marshall has established an office at Roanoke, Va., as consulting engineer, chemist and metallurgist of foundries, blast furnaces, coke ovens. He formerly was manager of the American Manganese Mfg. Co., Dunbar, Pa., and at one time served as general superintendent of the property and business of the Aluminum Co. of America in North Carolina.

Lawrence Fitch, president of the Western Malleables Co., Beaver Dam, Wis., and treasurer of the Globe Seamless Steel Tubes Co., Milwaukee, was recently elected president of the reorganized Independent Harvester Co., Ltd., organized by Milwaukee capitalists who purchased the Independent Harvester Co., Plano, Ill. Other officers follow: Vice president, Albert J. Earling, chairman of the

board, Chicago, Milwaukee & St. Paul Railway Co.; secretary, A. W. Wilbrand, secretary, Western Malleables Co., Beaver Dam, and treasurer, Grant Fitch, vice president of the National Exchange bank, Milwaukee.

A. Magnuson, formerly affiliated with Henry E. Pridmore, Chicago, now is associated with the molding machine department of the Davenport Machine & Foundry Co., Davenport, Iowa. He is connected with the sales department of this company and will cover the central western territory including the states of Illinois, Wisconsin, Indiana and Michigan.

Death of J. L. Lanigan

J. L. Lanigan, a representative of the sales department of the International Molding Machine Co., Chicago, died at the Crouse Irving hospital, Syracuse, N. Y., Wednesday, May 15. Mr. Lanigan had a wide experience in the foundry business prior to his affiliation with the International Molding Machine Co. as salesman in Ohio, western Pennsylvania and western New York. Due to his intimate knowledge of foundry operations he was unusually successful as a molding machine salesman and he made an enviable record for himself in that capacity.

Death of Professor Hutton

Professor Frederick R. Hutton, who was secretary of the American Society of Mechanical Engineers for a period of 23 years and who was president of this organization in 1907, died on Tuesday, March 14. Professor Hutton was born in New York, May 28, 1853, and graduated from Columbia College in 1873. He subsequently entered the School of Mines and received his degree in 1876. A year later he was appointed instructor in mechanical engineering as an associate of Professor W. P. Trowbridge, this being the first recognition which Columbia College gave to the important relations of mechanical engineering to other engineering forces. In 1890 he became professor at this school. He was made head of the mechanical department of Columbia in 1892 and continued in this position until July 1, 1907. In 1883 Professor Hutton became secretary of the American Society of Mechanical Engineers and continued to serve in this capacity until January, 1906, when he declined re-election. The following December he was elected president.

Tungsten is obtained by heating scheelite or artificially prepared calcium tungstate with carbon, carbonaceous material or a reducing gas.

Berry Metal Co.'s Plant Completed

The Berry Metal Co., New Brighton, Pa., organized recently to engage in the manufacture of brass castings, has completed the erection of its foundry which is equipped to produce 150,000 pounds of brass, bronze and copper castings per month. The output will consist of railroad journal bearings, hot and cold neck rolling mill bearings, acid metal castings, babbitt metal and castings for blast furnaces including tuyeres, tuyere coolers and bosh cooling plates. W. D. Berry, president and general manager of the company, formerly was general superintendent of the Keystone Bronze Co., Pittsburgh. Walter V. Berry is secretary.

Will Make Marine Castings at Philadelphia

(*Concluded from page* 283)

The foundry is served with several standard-gage railroad tracks and loading stations. Thus, heavy castings that otherwise would involve difficulties in handling are readily taken care of and conveyed to other departments as occasion requires.

The Westinghouse company's new plant is well located to cope with the present inadequate transportation facilities which are hampering manufacturers engaged in war work in all localities. The plant is served by the Pennsylvania and Philadelphia & Reading railroads and the Philadelphia Rapid Transit Co. Eventually, the company intends to house approximately 5000 of its workingmen on its premises and a portion of its site has been reserved for this purpose.

Tool Companies Consolidate

The Independent Pneumatic Tool Co., Chicago, a New Jersey corporation, and the Aurora Automatic Machinery Co., incorporated in Delaware, have been consolidated under the name of the former and has been capitalized at $3,000,000. The directors of the company follow: John P. Hopkins, chairman; John D. Hurley, James J. McCarthy, William A. Libkeman, Leonard S. Florsheim, Edward G. Gustafson, Robert T. Scott, Ralph S. Cooper, August Gatzert and Fletcher W. Buchanan. The following officers have been elected: John D. Hurley, president; Ralph S. Cooper, vice president; Fletcher W. Buchanan, secretary; and Edward G. Gustafson, treasurer. The general offices of the company are in the Thor building, 1307 South Michigan boulevard, Chicago. The pneumatic and electric tool plant is located at Aurora, Ill., and motorcycles and gasoline engines are manufactured at 361 West Superior street, Chicago.

Peerless Sand Company Organizes

U. E. Kanavel and C. M. Bixler, who have had wide experience in mining sand for foundry purposes, have organized the Peerless Sand Co., at Conneaut, O. U. E. Kanavel is president of the company; C. M. Bixler, secretary and general manager and F. L. Moore, vice president and sales manager. The company will buy, sell and load molding sand, but does not expect to erect a plant immediately. Mr. Kanavel formerly was affiliated with the Ayres Mineral Co. and the Ayres Asphalt Paving Co., Zanesville, O.; the Interstate Sand Co., Cleveland, and the Ohio Sand Co., Conneaut, O. Mr. Bixler formerly was associated with the Portage Silica Co., Youngstown, O.; the Trumbull Clay Products Co., Warren, O., and during the past year he has been connected with the Gordon Sand Co., Conneaut. F. L. Moore, sales manager of the Peerless Co., at one time was connected with the Interstate Sand Co.

A New Gas Fired Furnace for Refining Iron

(*Concluded from page* 282)

malleable, has bending qualities, and takes a high polish.

The refining operation in the furnace is relatively simple. The action of the flame cleanses the metal, removing the free carbon, oxides and occluded gases. The metal is heated until it is still and dead like crucible steel. Slag may be used to remove sulphur ,and phosphorus if they exist to too high a degree in the scrap.

A metal of uniform analysis for the manufacture of shells is produced as semistee , with a tensile strength of 40,000 pounds. The furnace may be operated independently of a cupola, charging the cold scrap direct, if desired, but this requires more time for melting and refining.

The furnace at the Garden City plant is operated on gas from the city main. It contains about 500 b.t.u. per cubic foot. As previously stated, about 5 per cent of compressed air is employed, the remaining 95 per cent of air being drawn in by the vacuum thus established. About 10 volumes of air to one of gas are delivered at the burner. Changes in the supply of gas and air are controlled by one valve. The gas supply is reduced to obtain a higher oxidizing action and the proportion of air is reduced to obtain a reducing effect. During the refining action, the flame usually is maintained at the neutral point.

Equipment for Iron, Steel and Brass Foundries

Roll-Over Molding Machine—Removing Water from Compressed Air—Pouring Device for Ladles —Core Oven for Portable Racks—Oil-Fired Nonferrous Furnace—Air Pressure Governor

NEW roll-over molding machines of the balanced type have been developed by the Champion Foundry & Machine Co., Chicago. Its features are shown in the accompanying illustrations. The machine consists of a frame carrying a yoke mounted on trunnions in such a manner that the mold is rolled-over by gravity. The yoke is equipped with a clamping frame which holds the flask in place while it is being rolled over. A compression cylinder also is provided. The machine is designed primarily for making cores although it is equally well adapted for light molding operations. Several types have been developed to take care of varying power conditions and a range of sizes. The machine is easily portable.

Fig. 1 shows the machine in the initial position with the clamping frame swung back to facilitate ramming the mold. After this operation is completed the clamp is swung down to its working position where it locks automatically. The flask is then raised by the air cylinder until its center of gravity is above the axis of the trunnions. The entire yoke carrying the flask may then be rolled over, gravity performing most of the work.

Fig. 2 shows the machine after the roll-over operation is completed and the core drawn out of the core box. A steady draw is insured by the two steel guides placed on either side of the air cylinder. When the core or mold is removed from the clamping frame, the center of gravity is again transferred to a point above the axis of the trunnions and the yoke may be readily rolled back to its initial position.

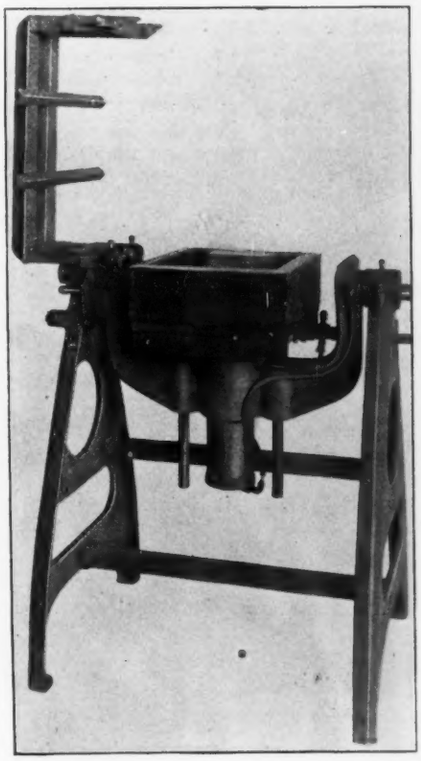


FIG. 1—BALANCED ROLL-OVER MOLDING MACHINE IN INITIAL POSITION

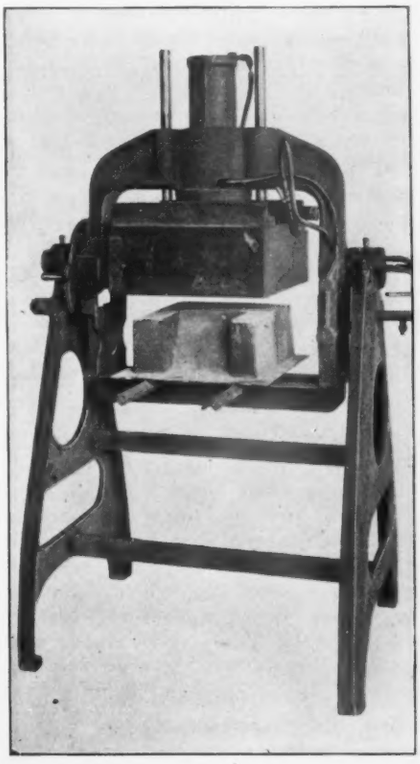


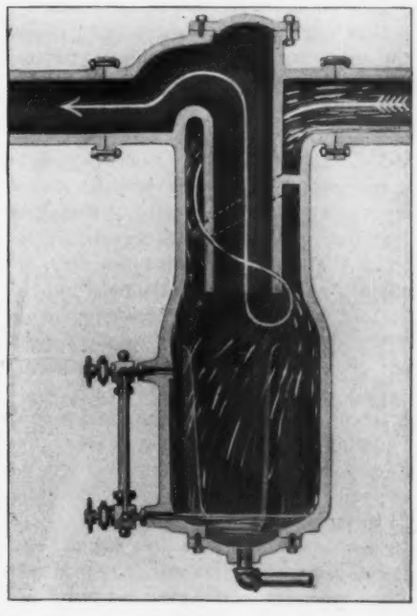
FIG. 2—BALANCED ROLL-OVER MACHINE IN FINAL POSITION

A 16-inch machine, which is shown in the accompanying illustration, will accommodate a flask or core box with overall dimensions of 20 x 30 inches. These machines are made in three types including hand-ram and power-draw, hand-jolt and hand-draw, and power-jolt and power-draw. The machine is built in a range of sizes up to 48 inches capacity. The largest size is provided with a brake to control the roll-over and an air cylinder to absorb the shock at the end of the swing into the downward position.

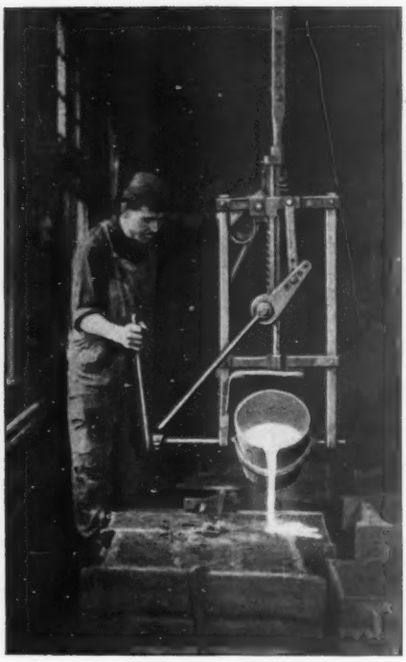
Removing Water From Compressed Air

A device designed to remove water from compressed air in sand blast machines is being manufactured by the Griscom-Russell Co., 90 West street, New York. It is due to the water in compressed air that sand packs in the sand chamber and fails oftentimes to flow freely from the sand blast nozzle. This results in delays, as frequent shutdowns are necessary for cleaning the machine.

In the functioning of its work, the Griscom-Russell device, which is known as the Stratton air separator and is shown in the accompanying illustration, utilizes the principle of centrifugal force. Originally, the air after compression is at a comparatively high temperature and is usually passed through an after-cooler to reduce this temperature to such a point that the water vapor will be condensed. This after-cooler, however, merely serves to bring the air into a suitable condition for the removal of water, but does not eliminate the water. It is at this juncture that the air separator is designed to be of service and it is here set in the line.



DEVICE FOR REMOVING WATER FROM COMPRESSED AIR, ESPECIALLY DESIGNED FOR SAND BLAST



POURING DEVICE FOR LADLES AND CRUCIBLES

The water and the air enter the separator and are freed to pass through a helical path formed about a central core which imparts a whirling motion to the entire mass. As water is much heavier than air, it does not turn corners as easily. At any sharp turn, centrifugal force throws the water to the outside, against the wall which forms the bend, whereas the air makes the turn and goes on without the moisture. With a properly formed bend, large or small, quantities of water will swing out of the curving current, meet the wall at an angle, and slip smoothly along without the slightest spatter or splash, adhering close to the wall until the motion dies out. It is by this general principle that the separator finishes its operation. While the separation of the air and water is complete, it is said that the pressure loss through the use of the separator is negligible.

This separator is made of close-grained cast iron, is simple in construction and has no internal movable parts. It is applicable to compressed air apparatus of virtually all descriptions, is suitable for a working air pressure up to 160 pounds per square inch and is made in various types of inlet and outlet to suit different piping arrangements.

In the manufacture of a new aluminum solder, recently patented, the tin and zinc are separately melted in crucibles lined with aluminum oxide, 70 parts; carbon, 20 parts, and the binder constituting the remaining portion. Aluminum may be added.

A Pouring Device for Ladles and Crucibles

A pouring device for small ladles and crucibles has been developed by Max Goldberg, 1378 W. Twenty-fourth street, Milwaukee. Its principal features are shown in the accompanying illustration. The ladle is carried in a framework which is suspended from a crane or monorail by a steel rod. A rack and pawl mechanism mounted on the lower end of the suspension rod is employed for adjusting the ladle to the proper height. It is said that molds from 4 to 30 inches in height may be poured without altering the length of the suspension rod. The ladle or crucible is supported in an ordinary trunnion ring which is tilted by a handle in the usual manner. This device may be used for other purposes than pouring molds. When provided with a platform in place of the ladle, it may be employed as a core carrier or for handling castings. It also may be utilized for shaking-out molds since it is stated that a pull of 75 pounds on the ratchet lever gives a lift of 500 pounds on the adjustable frame.

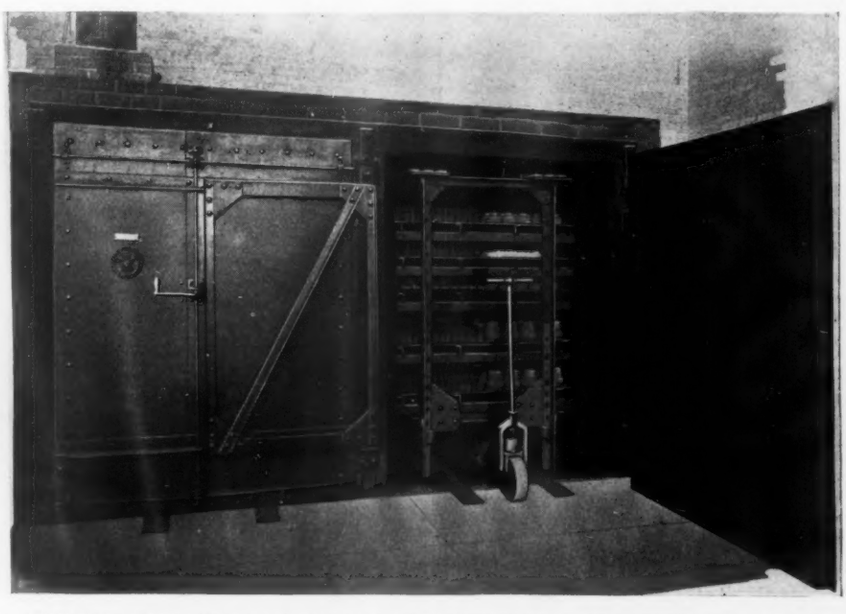
Specially Designed Core Oven for Portable Racks

Although lifting platform trucks have been in use only a comparatively few years, their employment in the handling and movement of various kinds of material has become widespread. In a number of foundries they have been adopted for conveying cores placed on portable racks. In the shops where these trucks and portable racks are used the floors must be kept in good condition to prevent transmitting excessive vibration to the cores. Also, it is essential that the core room be so laid out that the easy and rapid movement of the racks is facilitated.

A type of core oven designed specially for baking cores on portable racks handled by trucks, either of the hand or electric storage battery type, has been developed by the Foundry Equipment Co., Cleveland. These ovens are built to accommodate any size or number of racks. The ovens can be fired with coke, gas or oil and are heated from below the floor level, the heat being introduced through a series of flues. Draft regulation is provided for the control of the temperature and the removal of the gases.

One of the advantages of this method of baking cores is the speed with which these cores may be handled. On certain classes of work the output is greatly increased over the car type oven. Furthermore, no track system is required, although a smooth floor is essential. In the accompanying illustration is shown a battery of two of these ovens with a rack containing cores ready to be withdrawn by a lifting platform truck.

The Foundry Equipment Co. also has developed a new type of insulated oven door which can be used either in connection with car or rack ovens. This door is built of two thicknesses of steel plate between which is placed an insulating medium and unlike ordinary hinged doors it is supported by an independent steel frame hinge that supports the door at the center. This enables the door to be swung freely and when closed forms a tight joint on all sides.



SPECIAL TYPE OF RACK CORE OVENS EQUIPPED WITH INSULATED DOORS

As shown in the accompanying illustration, a single movement of the handle locks the door at four points and a single pull on the handle likewise releases the door and permits the operator to swing it open. This type of door is used where there is insufficient headroom to permit the installation of a counterweight lifting door and also where there is ample floor space to permit the doors to be swung.

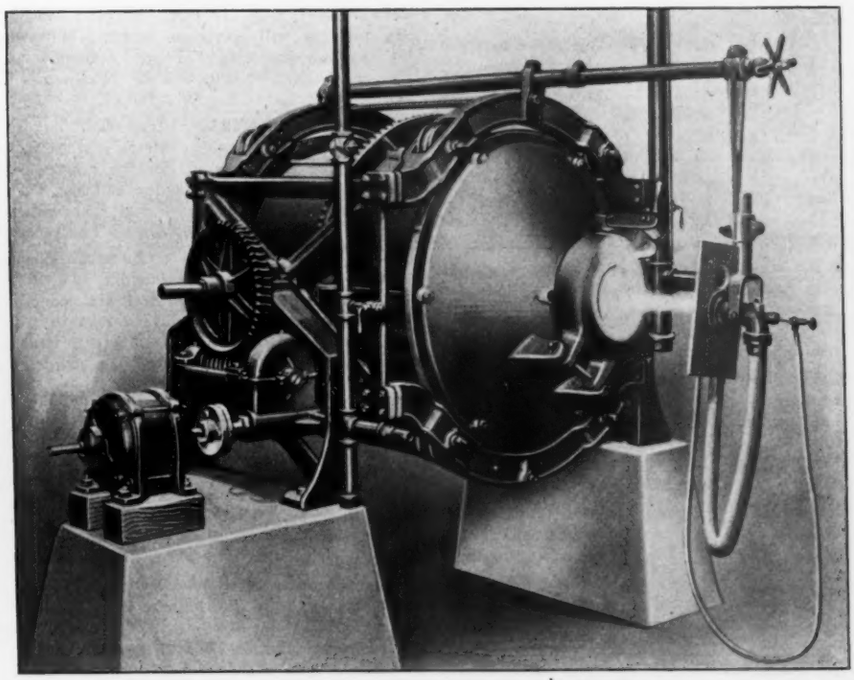
Oil-Fired Nonferrous Melting Furnace

A new oil-fired furnace for melting nonferrous metals has been developed by the U. S. Smelting Furnace Co., Belleville, Ill. A gas flame may be used for heating the furnace instead of oil if desired. The steel shell of the furnace, which is cylindrical, is mounted on trunnions so that the furnace may be rotated on its axis for melting and tilted for pouring. Either hand or motor power may be used for rotating the furnace. When pouring, a hand wheel operated through a worm gear is employed.

The furnace is charged through the central opening which admits the flame, the burner being swung aside. It is stated that the burner may be easily adjusted and lighted. The flame is projected into the center of the furnace above the metal and the burner is so arranged that the flame does not touch the surface of the bath. This tends to minimize metal losses. The lining becomes highly heated and as the furnace rotates this heat is imparted to the bath. It is claimed that this method of applying the heat insures an even temperature throughout the furnace, thus assisting in the purification of the metal. The operator has the metal under close observation at all times and can see when it is ready for pouring.

When pouring, the furnace can be tilted to a perpendicular position and its conical shape permits the last ounce of metal to drain off. Because of this feature it is claimed that different mixtures can be melted in sequence without difficulty. It is claimed that this furnace is specially adapted to remelting grindings, sweepings, etc., which ordinarily might be wasted or sold at a comparatively low price. The general arrangement of the furnace is shown in the accompanying illustration. It is built in four sizes, ranging in capacity from 200 to 2500 pounds at a charge.

FIG. 1—CONTACT MAKING PRESSURE GOVERNOR WITH INTERNAL RELAY



TILTING OIL OR GAS FURNACE FOR MELTING NONFERROUS METALS

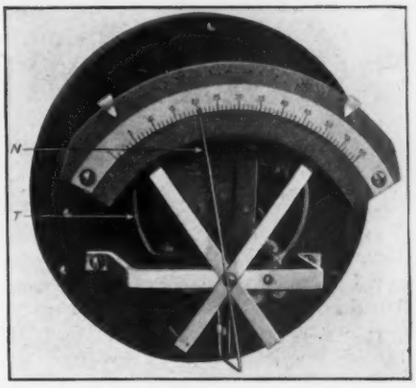


FIG. 2—INTERNAL MECHANISM OF PRESSURE GOVERNOR

Pressure Governor for Gas and Air

A pressure governor to control standard self-starters for motor-operated pumps and compressors has been developed by the General Electric Co., Schenectady, N. Y. The governor maintains a pressure between predetermined limits on any gas, air or liquid system that will not corrode the Bourdon tube. The governor can be attached to any alternate or direct current circuit and it is rated for pressures of 80, 100, 160, 300 or 500 pounds and operated within a setting of from 3 to 12 pounds between high and low pressures. Governors for higher pressures also will be supplied.

The governor consists of a Bourdon tube, an indicating needle, a graduated pressure scale, adjustable high and low pressure stops to determine the desired pressure range and a relay which actuates the contacts in the control circuit of the self-starter. This mechanism is enclosed in a dustproof case, Fig. 1, which is easily opened for inspection. The action of the governor is dependent on the Bourdon tube which should be connected to an independent discharge pipe from the pressure tank. The free end of the tube *T*, Fig. 2, is connected to the indicator needle *N* moving it over the scale as changes of pressure affect the tube. After the settings for the pressure range have been made, the governor automatically will maintain the pressure within these limits.

Crocker Bros., manufacturers and merchants of pig iron, coke, etc., have removed their offices from 30 East Forty-second street to 21 East Fortieth street, New York.

The Paul Wenger Co., New York, dealer in copper, aluminum, tin, lead and other metals, has removed to larger quarters and now is located at 56 to 58 Liberty street and 35 Nassau street.

WHAT THE FOUNDRIES ARE DOING

Activities of the Iron, Steel and Brass Shops

The Swedish Crucible Steel Co., Windsor, Ont., is building an addition to its foundry.

The Federal Malleable Co., West Allis, Wis., is planning to enlarge its foundry.

The Powell-Mahin Co., Tulsa, Okla., is building a machine shop and foundry.

The Fairmount Foundry Co., Philadelphia, is contemplating the erection of an addition to its plant, 22 x 100 feet.

The Bay View Foundry Co., Sandusky, O., is contemplating the erection of a foundry addition.

The Riverside Iron Works, Chicago, will build a foundry addition, 60 x 75 feet. R. G. Pierce is architect.

The Lansdale Foundry Co., Lansdale, Pa., will erect an addition to its foundry, 70 x 120 feet.

The Edro-Richardson Brass Co., Baltimore, has acquired a factory which will be converted into an extension to its foundry.

The McDonald Foundry Co., Columbus, is contemplating the erection of a small addition to its plant.

The John B. Morris Co., Cincinnati, has applied for permits for two foundry additions to cost $6600.

The H. & H. Foundry, 778 Pacific street, Stamford, Conn., plans the erection of another building to be used as a steel foundry.

The John E. Thropp Sons Co., Trenton, N. J., have completed preliminary plans for a $50,000 foundry, 1-story, 100 x 350 feet.

The Eureka Brass Co., St. Louis, is reported to have plans completed for the erection of an addition to its foundry.

A machine shop and foundry is being erected for the Lamb Machine Works, Hoquiam, Wash. An electric furnace will be installed.

The Pittsburg Rolls Corp., Pittsburgh, has obtained a permit to erect a 1-story brick and steel foundry building at a cost of $6000.

The National Foundry Mfg. Co., Williamsport, Pa., has let a contract for a 1-story building 48 x 115 feet.

The Gary Foundry & Machine Co., East Gary, Ind., is building an addition to its foundry, 24 x 86 feet.

The Hercules Steel Castings Co., Milwaukee, will build a steel foundry at a cost of $100,000.

The Green Engineering Co., East Chicago, Ind., is building a foundry addition, 45 x 100 feet, at a cost of $15,000. F. A. Keaser is superintendent.

The Foundry Equipment & Metals Co., Covington, Ky., recently was chartered to manufacture foundry machinery and tools. It has a capitalization of $10,000.

The Production Pattern & Equipment Co., Milwaukee, has been chartered with a capital of $25,000 to manufacture patterns and foundry equipment.

The Flower Stephens Mfg. Co., Detroit, will build a foundry addition, 37 x 150 feet, at a cost $18,000. John W. Flower is president of the company.

The Aetna Foundry Co., Inc., Philadelphia, has awarded the contract for a 1-story addition, 50 x 70 feet, and 20 x 50 feet, to A. Raymond Raff, Philadelphia.

A new manufacturing building and warehouse, 60 x 100 feet, will be erected by A. Locke & Co., Sheboygan, Wis., operating a foundry, machine shop and scrap metal yard.

The Monarch Tractor Co., Watertown, Wis., is planning the enlargement of its foundry, under its recently announced plant extension program.

The Decatur Malleable Iron Co., Decatur, Ill., is planning the construction of a foundry. Schmidt, Garden & Martin, Chicago, are the architects.

The Hershey Foundry & Machine Co., Manheim, Pa., will build a one and 2-story foundry and pattern shop, 110 x 200 feet, at a cost of $25,000.

The Wright Steel Foundry, Seattle, has been incorporated for $100,000 by E. E. Hinsdale, Charles Stewart and Ruby E. Wright.

The Pacific Foundry Co., San Francisco, is planning to build a steel frame foundry costing $40,000. H. C. Vensane, 110 Sutter street, is architect.

Plans are being prepared for the erection of a $35,000 foundry for the John Polachek Bronze Iron Co., Long Island City, L. I., N. Y. R. Holstein is the architect.

The International DeLavand Mfg. Corp., Toronto, Ont., recently was incorporated with $600,000 capital, to operate a foundry and machine shop.

The Liberty Foundry Co., Portland, Oreg., will build a foundry and machine shop, 50 x 100 feet, for which new equipment will be needed.

Bids soon will be taken by the Austin Co., Cleveland, on a $30,000 foundry addition for the Pottsville Iron & Steel Co., Pottsville, Pa. The proposed structure will be 99 x 120 feet.

The Universal Machinery Co., West Allis, Wis., will build a foundry 100 x 150 feet, a factory building, 150 x 250 feet and a powerhouse at a cost of $250,000. E. C. Devine is president of the company.

A brick and concrete foundry, 30 x 110 feet, will be erected by the Rosenthal Corn Husker Co., West Allis, Wis., to replace the shop damaged by fire. It is estimated the new plant will cost approximately $15,000.

The Detroit Gray Iron Foundry Co., Detroit, will build a sand storage and handling building, 80 x 400 feet, and a foundry addition 20 x 60 feet, at an estimated cost of $80,000.

The American Radiator Co., Titusville, Pa. has awarded a general contract to the J. W. Cowper Co., Inc., for the construction of a $25,000 foundry. The new building will be 80 x 100 feet.

The Liberty Foundry, Inc., Portland, Oreg., has been incorporated with a capitalization of $50,000, by William Cornfoot and associates. The plant of the Lister Sash Weight Co. has been leased and will be equipped for a foundry and machine shop. The company plans to add electric welding and brass casting departments.

The National Metal Stamping & Mfg. Co., Newark, N. J., will erect a brick and steel machine shop and foundry at a cost of $20,000. The building will be 1-story, 90 x 120 feet.

The firm name of the Inland Steel Castings Co., Terre Haute, Ind., has been changed to that of the Inland Malleable Iron & Steel Co. since the bulk of the tonnage of this plant consists of malleable iron castings.

The Crescent City Machine & Mfg. Co., New Orleans, will install equipment to increase its foundry, machine and boiler plant. The improvements will cost approximately $100,000.

The Holmes Foundry Co., Ltd., Sarnia, Ont., has been incorporated with a capital of $500,000, by Lyman A. Holmes, Louis C. Blunt, William F. Cooper, all of Port Huron, Mich., and Anthony I. McKinley, Sarnia.

The Universal Machinery Co., Milwaukee, is planning to build a new plant in West Allis, Wis., including a foundry, 90 x 150 feet; machine shop, 150 x 300 feet and boiler and transformer house, 40 x 60 feet.

The Electric Steel Co., Chicago, has awarded a contract to the E. W. Sprowl Co., Chicago, for a foundry addition, 130 x 300 feet, at a cost of $75,000. S. Scott Joy, 1118 West Thirty-fifth street, is the architect.

The Ampco Rolling Mills Corp., Milwaukee, is having plans prepared for converting the plants of the Globe Iron Works and the Laursen Automatic Pump Co., into a foundry and rolling mill. The foundry will be equipped an electric furnace.

The Berry Iron & Steel Co., St. Joseph, Mo., will rebuild its plant recently damaged by fire and will erect five buildings in place of the two foundries. The main foundry will be 50 x 260 feet and will be equipped with two cranes.

The Trenton Malleable Iron Co., Trenton, N. J., has awarded the contract to the N. A. K. Bugbee Co., Trenton, for the construction of a brick and steel foundry addition. The building will be 146 x 44 feet and will be erected at a cost of $10,000.

The Green Foundry & Furnace Works, Des Moines, will build a foundry 106 x 110 feet, and will remodel a steel and concrete building recently purchased at a cost of $75,000. Frank D. Chase, 122 South Michigan avenue, Chicago, is the engineer in charge.

The gray iron foundry of the Peerless Foundry Co., Hamilton, O., recently damaged by fire, is to be rebuilt in one of the suburbs of Cincinnati. The building will be 120 x 200 feet. There also will be a pattern vault, pattern shop, core building and general office building. The new plant will be built under the direction of Frank D. Chase, Inc., Chicago.

The Lebanon Steel Foundry Co., Lebanon, Pa., has let contracts for the erection of an annex, 100 x 200 feet, to its plant. A second two-ton electric heroult furnace is to be installed, with a sufficient number of annealing furnaces, to meet the demands made upon it for government work.